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**MONITORING AND CONTROLLING
ENGINEERING AND CONSTRUCTION
MANAGEMENT COST PERFORMANCE
WITHIN THE CORPS OF ENGINEERS**

Report AR801R1

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Executive Summary

MONITORING AND CONTROLLING ENGINEERING AND CONSTRUCTION MANAGEMENT COST PERFORMANCE WITHIN THE CORPS OF ENGINEERS

The U.S. Army Corps of Engineers (USACE) provides engineering and construction management services for approximately \$7 billion of military construction and civil works projects each year. The USACE currently has no cost standards for managing those services, and using indirect cost rates in place of such standards does not provide an adequate measure of cost performance.

We have developed cost standards for the military and civil works programs, by USACE customer type, that show total service cost — both direct and indirect — as a percent of the construction cost. We developed the standards from a combination of USACE and private-sector data.

We recommend that the Director of Resource Management adopt the cost standards and implement a cost-monitoring strategy to statistically compare, on a quarterly basis, the actual cost performance of each USACE district with the standards. Using this approach, USACE will be able to identify areas where improvements are needed. We expect greater improvements will occur in engineering cost performance, where we found USACE costs somewhat higher than industry averages, than in construction management where USACE costs are below or comparable to industry averages.

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FIELD	GROUP	SUB-GROUP													
19. ABSTRACT (Continue on reverse if necessary and identify by block number) → The U.S. Army Corps of Engineers (USACE) provided \$7 billion worth of design, engineering, design and engineering management, and construction management services for the military construction (MILCON) and the civil works programs in FY88. Since cost control is a major part of USACE's management responsibilities, their customers expect strict control of authorized funds and adherence to established budgets. This expectation has been heightened by the decreased MILCON budgets of recent years and by legislative initiatives such as the Water Resource Development Act of 1986. Comparisons with firms providing construction management for projects of similar complexity such as roads, bridges, tunnels, and heavy industrial facilities indicate that USACE construction management costs for its military program are below the industry average for comparable work and its engineering and design costs for the military program are higher than industry averages. We also find that the direct-to-indirect cost ratio varies greatly within the engineering and construction industries. The variance is even more dramatic for USACE organizations and is the result of different interpretations of USACE policies that encourage the direct charging of as many costs as possible. These variances prevent using indirect cost rates as a basis for controlling costs – the cornerstone of most current USACE cost management efforts.															
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CHAPTER 1

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) provides engineering and construction management services for an annual \$3 billion military construction (MILCON) program and a \$4 billion civil works program.¹ It provides those services to customers in the continental United States (CONUS) and abroad (OCONUS) through an organization of districts and divisions. USACE also provides planning support for the civil works program and operates completed projects such as locks and dams.

In 1985, the Directorate of Resource Management (DRM) began a multiyear program to improve cost management. At the same time, legislative initiatives have caused USACE's cost performance to come under increased scrutiny. The Gramm-Rudman-Hollings Act has increased budgetary pressures and made USACE customers more cost-conscious and concerned that they are getting their money's worth. The Water Resources Development Act of 1986 increased the requirement for cost-sharing from local sponsors making them more concerned with project costs and more willing to obtain engineering services from other organizations if USACE is not cost-competitive.

Successful cost management is based upon three major components: setting standards, monitoring performance, and improving performance. Although these components must be developed or performed sequentially, they have a number of feedback loops (see Figure 1-1). Established standards must sometimes be revised on the basis of the results of initial performance monitoring, and performance can be improved by taking actions to correct deficient areas identified by monitoring and/or by raising standards if initial ones are being met. We believe USACE cost management can be described with this generalized model.

Cost management can be improved through a series of specific actions we refer to as supporting initiatives. Table 1-1 shows the minimal supporting initiatives that

¹Engineering includes design services, engineering services, and design/engineering management.

Principles of Cost Management

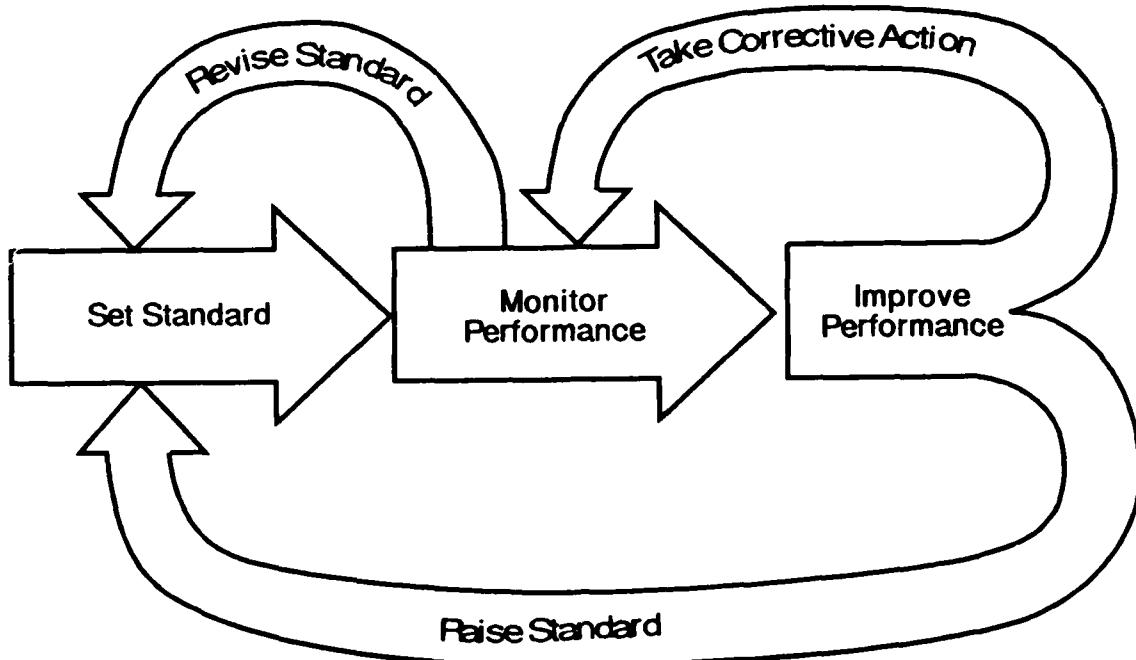


FIG. 1-1. COST MANAGEMENT

a USACE cost management strategy should address. In this report, we examine three of the engineering and construction management initiatives: (1) establishing total cost standards, (2) developing a customer-level monitoring strategy, and (3) assessing existing cost performance versus that of the private sector.

In Chapter 2, we present a comparison of USACE and private sector engineering and construction management costs, and in Chapter 3, we present a strategy for monitoring the USACE costs at the customer level. In Chapter 4, we propose total cost standards for USACE engineering and construction management and in the final chapter, give our conclusions and recommendations for future action.

TABLE 1-1
COST MANAGEMENT

<u>Major component</u>	<u>Supporting initiative</u>
Setting standards	<ul style="list-style-type: none">● Developing intermediate and long-term goals● Establishing total cost standards● Tightening overhead definitions● Developing an overhead staffing model● Developing a total staffing model
Monitoring performance	<ul style="list-style-type: none">● Developing a customer-level monitoring strategy● Developing a project-level monitoring strategy● Assessing existing cost performance versus that of the private sector
Improving performance	<ul style="list-style-type: none">● Defining unacceptable performance● Establishing incentives (positive and negative)

CHAPTER 2

COMPARISON OF USACE AND PRIVATE-SECTOR COSTS

PREVIOUS STUDIES

In 1983, the Deputy Assistant Secretary of Defense (Installations) [DASD(I)] tasked LMI to compare engineering and construction management costs for the USACE and the Naval Facilities Engineering Command (NAVFAC) to those of other Government agencies and the private sector. The Government agencies used in the comparison were the General Services Administration (GSA), the Veterans Administration (VA), and state governments. Several large corporations were used for the private-sector comparison.

In that 1983 study, we used a selected sample of completed projects for USACE, NAVFAC, and GSA and the average costs for various size projects for the state governments, the VA, and the private-sector corporations. That analysis showed that after accounting for differences in project complexity and size, USACE aggregate costs for design, engineering, and construction management services compared favorably with those experienced by other Government agencies and large corporations providing similar services.¹

In 1985, the DASD(I) asked LMI to compare the costs of constructing certain facilities under the MILCON program with similar costs in the private sector. In that 1985 study, we used parametric construction costs — dollars per square foot — to compare the costs of six types of facilities with the costs for similar private-sector buildings. In five of the six types, MILCON costs were found to be generally equivalent to those in the private sector, and in all cases they were found to be less than those of other Government agencies.

Those two studies made macro comparisons of MILCON costs and may satisfy general inquiries on average DoD-wide costs; however, they did not provide information for analyzing and managing costs at the service level. Effective cost

¹*Management Costs of DoD Military Construction Projects*, LMI, 1983.

management requires a more detailed examination that provides specific information to managers.

CLASSIFICATION OF COSTS

The key to establishing useful categories of engineering and construction management costs is to group like projects together to create homogeneous categories. We created categories by grouping projects by type of work. For the MILCON program, the type of work can be described by fund type – the source of funds and customer. For the civil works program, the physical characteristics of the project, regardless of the fund type, is the most effective classification technique. This categorizing is similar to defining the customer lines for a large engineering and construction organization, and we have adopted that terminology in this report for both the military and the civil works programs. The full listing of customer categories is shown in Table 2-1.

In each category of customers, different types of costs are identified. In general, costs are usually either direct or indirect. However, the construction industry, and USACE in particular, identify four types of costs: direct costs, burden costs, technical indirect costs, and general and administrative overhead costs (G&A). Direct costs are costs that are directly chargeable to a project and include such costs as direct labor, travel, and contracts. Burden costs are charges for fringe benefits paid to employees such as sick and annual leave. Technical indirect costs include such costs as supervisory labor and other indirect costs that are pooled and then applied directly to projects. G&A costs are overhead costs that cannot be allocated to specific project accounts or technical units.

Two cost comparisons are possible: the total cost of providing a service, and the indirect cost rates. The total cost comparison is the more meaningful since it reflects the complete cost of providing a service. The comparison of indirect costs is less meaningful since those costs are normally expressed as percentages of direct labor. Consequently, accounting practices and policies – within USACE or in private-sector firms – can result in an item being a direct cost in one organization and an indirect cost in another. Engineering and construction organizations can charge the same price to produce a product but have very different indirect cost rates. For that reason, we base most of our analysis on total costs.

TABLE 2-1
USACE CUSTOMER CATEGORIES

Military construction	Civil works
Family housing – Army	Channels and harbors
Family housing – Air Force	Locks and dams
MILCON – Army	Beach erosion control
MILCON – Air Force	Flood control
MILCON – Army Reserves	Flood control reservoirs
MILCON – other	Multipurpose power
O&M – Army	Rehabilitation – channels and harbors
O&M – Air Force	Rehabilitation – locks and dams
Production base support	EPA Superfund
DERA	EPA construction grants
	O&M – channels and harbors
	O&M – locks and dams
	O&M – flood control
	O&M – flood control reservoirs
	O&M – multipurpose power
	O&M – channel and harbor improvements
	Flood control – rehabilitation
	Flood control – construction
	Recreation

Note: O&M = operations and maintenance; DERA = Defense Environmental Restoration Act; EPA = Environmental Protection Agency.

DATA SOURCES

USACE Data Sources

Cost data for USACE are maintained in the Corps of Engineers Management Information System (COEMIS). Although COEMIS is the database of record for all financial information, some cost information in a more readily analyzed format is available in both the Automated Military Projects Reporting System (AMPRS) and the Project Reporting Information System for Management (PRISM).

Engineering and construction management costs for the MILCON program are contained in the military module of COEMIS. Engineering costs are maintained by

project in COEMIS and are periodically used to update AMPRS. Since no USACE-wide COEMIS database exists, the total costs for MILCON engineering were extracted by project from the USACE-wide AMPRS database. Actual construction management costs, however, are not maintained by project in either COEMIS or AMPRS; they are captured in expense accounts in the COEMIS revolving fund and are not directly linked to construction projects. Project-level construction management costs in AMPRS are simply the Supervision and Administration (S&A) flat rate applied to the construction placement and do not reflect actual costs. Consequently, actual costs cannot be measured directly by project. However, an accurate estimate of the actual construction management costs can be obtained by using the Corps of Engineers Resource and Military Manpower System (CERAMMS), which can accurately estimate the manhours required for different types of construction management. That estimate can then be combined with the fully burdened manhour cost to develop the construction management costs associated with a project. A detailed discussion of this methodology is presented in Appendix A.

Engineering and construction management costs for the civil works program come from three sources: the civil module of COEMIS, the PRISM database, and manual records maintained by USACE districts. Since civil works projects can span as many as 10 to 15 years, it may be necessary to obtain data from all three sources to get complete cost data for a project. A data call to all USACE districts was used to acquire the necessary cost information. The data call addressed total engineering and construction management costs as well as indirect costs and component parts of the total costs. The results of this data call are discussed in detail in Appendix B.

Private-Sector Data Sources

Two sources were used to develop engineering and construction management cost data for the private sector. Direct and indirect engineering cost experience was obtained from annual surveys performed by the Professional Services Management Journal (PSMJ). The surveys are presented in two volumes: the *Financial Statistics Survey* and the *Design Services Fee Structure Survey*. The *Financial Statistics Survey* represents cost information from 420 engineering firms, and the *Design Services Fee Structure Survey* is developed from responses from 774 firms. These

databases provided detailed cost information by type of firm and by type of project and were the basis for making engineering comparisons.

Construction management costs were developed from a survey conducted by the Construction Management Association of America (CMAA) of its member firms. The CMAA database is a compilation of cost data for 162 private-sector construction projects from all parts of the country. A description of the survey process and summaries of the responses are presented in Appendix C.

TOTAL COST COMPARISONS

The amount and type of engineering or construction management services provided on private-sector projects vary significantly from project to project. An owner may contract for a "full" set of services or may decide to purchase only selected services. USACE projects differ, however, since organizational capabilities, statutes, and established policies frequently dictate where and how much work will be performed. Consequently, a differential between private-sector and USACE costs may only reflect differences in services received and not relative efficiency.

Project costs must be normalized to reflect the provision of a commonly defined full set of services before making any comparisons. For engineering services, we used the full set of services defined by PSMJ that included those services identified in the American Institute of Architects (AIA) document B141 along with some additional services such as predesign services and cost estimating. For construction management services the full set of services was taken to be those services identified in the *CMAA Standards of Practice Manual*. We found that, despite some minor differences in terminology, these definitions applied to both private sector and USACE projects.

We normalized the costs by determining the percentage of the total cost that could be allocated to each service and then adjusting the reported project costs for the services not provided. The normalized full-service costs were then used in comparisons. A detailed discussion of the normalization process is presented in Appendices D and E. Appendix F contains a list of fund types and work included in USACE customer categories as well as the mapping of private-sector projects to USACE customer categories.

MILCON vs. Private Sector

The full-service engineering cost factors for the MILCON program are compared with those experienced in the private sector in Table 2-2. The cost factors shown in this and similar tables are determined by dividing the cost of a specific service by the total construction contract amount.

TABLE 2-2
MILITARY ENGINEERING COST FACTOR COMPARISONS

Customer	Private sector			USACE Median
	25th percentile	Median	75th percentile	
Family housing – Army	4.9%	7.3%	9.1%	5.3%
Family housing – Air Force	4.9	7.3	9.1	5.7
MILCON – Army	4.9	6.3	8.0	7.1
MILCON – Air Force	4.9	6.3	8.0	8.1
MILCON – Army Reserves	5.5	7.1	8.7	9.6
MILCON – Other	4.8	6.9	8.4	7.8
O&M – Army	5.2	7.2	9.3	8.3
O&M – Air Force	5.2	7.2	9.3	9.6
Production base support	5.2	7.2	9.3	11.2
DERA	6.1%	8.0%	9.9%	7.0%

Note: Cost factors are the ratio of total engineering costs to the construction contract amount

The median USACE cost factor for each customer is compared to the range of comparable private-sector projects. The 25th percentile is the point in the range below which 25 percent of the projects cost less, while the 75th percentile is the point above which 25 percent of the projects cost more. Project costs vary significantly. We believe cost performance between the 25th and 75th percentile is reasonable, although not necessarily efficient. Most USACE engineering cost factors are less than the 75th percentile. The USACE weighted median based upon FY88 design placement for all customers is 7.0 percent while that for comparable private-sector projects is 5.8 percent.

The full-service construction management cost factors for the MILCON program are compared with those of private sector projects in Table 2-3.

TABLE 2-3
MILITARY CONSTRUCTION MANAGEMENT COST FACTOR COMPARISONS

Customer	Private sector ^a			USACE
	25th percentile	Median	75th percentile	Estimated average ^b
MILCON - Army	4.9%	7.0%	9.3%	5.4%
MILCON - Air Force	4.9	7.0	9.3	6.1
MILCON - Army Reserves	4.6	7.4	9.7	5.3
MILCON - other	4.6	6.7	9.1	2.2
O&M - Army	4.6	6.5	9.1	8.4
O&M - Air Force	4.6	6.5	9.1	9.3
Production base support	3.9	5.4	10.8	5.4
Family housing - Army	4.6	5.4	7.1	5.0
Family housing - Air Force	4.6%	5.4%	7.1%	5.3%

Note: Cost factors are the ratio of construction management costs to the construction contract amount.

^a Adjusted to reflect the same services as provided by USACE.

^b The estimated average is based upon the manpower utilized as determined by the CERAMMS model in conjunction with the fully burdened average USACE salary.

Again, project costs vary significantly. Most USACE construction management cost factors are less than the corresponding private-sector median cost factors. The USACE weighted average based upon FY88 construction placement for all customers is 5.4 percent while that for comparable private-sector projects is 6.5 percent.

USACE Civil Works vs. Private Sector

Few private-sector projects are similar to those found in the USACE civil works program. Consequently, we do not have data to provide a customer-by-customer private sector versus USACE comparison for civil works engineering and construction management. However, we do have data for private-sector projects that are of similar complexity to those found in the USACE civil works program. The cost factors for those projects are shown in Table 2-4 and Table 2-5. Although the projects

are of similar complexity, comparisons between these cost factors and those for the USACE in Table 2-6 and Table 2-7 should keep in mind the limited nature of the comparison.

TABLE 2-4
PRIVATE-SECTOR ENGINEERING COST FACTORS
(Civil works projects)

Customer	25th percentile	Median	75th percentile
Heavy industrial	3.0%	6.0%	10.0%
Bridges and roads (new)	3.0	4.5	5.5
Bridges and roads (rehabilitated)	3.0	5.0	6.0

TABLE 2-5
PRIVATE-SECTOR CONSTRUCTION MANAGEMENT COST FACTORS
(Civil works projects)

Customer	25th percentile	Median	75th percentile
Bridges, roads, and tunnels	4.8%	6.2%	14.2%

Total USACE civil works engineering costs are shown in Table 2-6. Like the MILCON program, civil works costs vary significantly between customers and within the category of customer. Civil works engineering cost factors are generally higher than those experienced on similar private-sector projects. The weighted median USACE engineering cost factor based on the FY88 program, which is dominated by flood control, lock and dam, and channel and harbor projects, is 12.4 percent for new construction and 4.5 percent for O&M work.

Table 2-7 displays total civil works construction management costs. Those costs vary significantly between and within categories of customers and are generally lower than those experienced on most similar private-sector projects. The

weighted median USACE construction management cost factors for the civil works program based on the FY88 program is 5.0 percent for new construction and 5.7 percent for O&M work.

TABLE 2-6
USACE CIVIL WORKS ENGINEERING COST FACTORS

Customer	25th percentile	Median	75th percentile
Channels and harbors	4.6%	9.3%	20.7
Locks and dams	3.6	11.0	21.3
Beach erosion control	5.0	10.5	15.6
Flood control	8.3	17.0	28.3
Flood control - reservoirs	5.7	9.5	14.2
Multipurpose power	7.5	11.3	16.1
Rehabilitation - channels and harbors	5.0	7.6	19.3
Rehabilitation - locks and dams	5.8	7.9	11.1
O&M - channels and harbors	2.2	4.7	9.2
O&M - locks and dams	2.8	2.9	3.2
O&M - flood control	3.0	3.6	4.6
O&M - flood control reservoirs	6.0	6.4	6.7
O&M - multipurpose power	2.9	4.1	6.3
O&M - channel and harbor improvements	4.7	10.4	3.4
Flood control - rehabilitation	18.0	26.8	56.3
Flood control - construction	9.6	14.0	16.3
Recreation	4.0	4.0	8.0

Note: Cost factors are the ratio of engineering costs to the construction contract amount.

INDIRECT COST RATES

Indirect cost rates are frequently thought of as a measure of the efficiency of an engineering or construction organization; organizations with low indirect cost rates are perceived as more efficient than those with higher rates. That perception is not correct. The classification of costs as direct or indirect is more an indicator of accounting practices and policies than of efficiency. A classic example of such policies is the charging of a principal's time in a design firm. Some firms charge principals' time directly to projects — a marketing strategy they believe is worth the

TABLE 2-7
CIVIL WORKS CONSTRUCTION MANAGEMENT COST FACTORS

Customer	25th percentile	Median	75th percentile
Channels and harbors	2.6%	5.5%	7.8%
Locks and dams	3.5	4.8	6.2
Beach erosion control	3.3	4.3	5.9
Flood control	3.5	5.6	8.7
Flood control – reservoirs	3.2	4.2	5.7
Multipurpose power	1.9	3.3	4.1
Rehabilitation – channels and harbors	1.5	3.3	10.4
Rehabilitation – locks and dams	3.8	5.3	7.9
O&M – channels and harbors	3.2	5.7	8.4
O&M – locks and dams	5.6	5.6	6.2
O&M – flood control	4.7	5.2	5.5
O&M – flood control reservoirs	5.6	5.7	5.7
O&M – multipurpose power	5.4	5.8	6.5
O&M – channel and harbor improvements	5.5	6.6	11.8
Flood control – rehabilitation	2.1	4.0	7.1
Flood control – construction	6.0	6.7	7.5
Recreation	5.1	5.5	5.8

Note: Cost factors are the ratio of construction management costs to the construction contract amount.

accounting effort. Other firms believe it is not worth the administrative effort and charge their principals' time to indirect pools and then distribute those pools to projects through indirect cost rates. Thus, a project with exactly the same total costs could have a much different ratio of direct to indirect costs. This trend is clearly visible in the PSMJ survey of design firms.

Although USACE regulations specify how costs should be classified, they permit significant judgment in identifying indirect costs. Consequently, USACE districts have indirect cost rates that vary greatly. The variances that exist in USACE costs are much larger than those exhibited in the private sector. Some reasons for these variances are discussed in Chapter 3.

Tables 2-8 through 2-11 show comparable private-sector indirect cost rates for both the MILCON and the civil works program. USACE average indirect cost rates are somewhat meaningless because of the large variances between districts, and therefore, we do not compare them with the private-sector ranges.

TABLE 2-8
ENGINEERING INDIRECT COST RATES FOR COMPARABLE PRIVATE-SECTOR PROJECTS
(Civil works)

Fund type	Technical/indirect				G&A				Burden				Chargeability*		
	25th	Median	75th	25th	Median	75th	25th	Median	75th	Median	75th	Median	75th	Median	75th
Channels and harbors	23.92%	32.30%	42.72%	81.25%	104.10%	118.50%	30.35%	34.22%	39.62%	59.62%	64.90%	69.06%			
Locks and dams	24.92	31.75	41.30	79.91	103.60	112.69	31.29	36.11	50.03	59.15	63.65	67.41			
Beach erosion control	20.61	29.45	39.92	78.59	99.45	103.11	26.48	32.69	37.98	54.15	63.30	67.51			
Flood control	26.66	33.30	41.20	82.75	101.65	112.08	30.60	34.34	39.83	59.07	63.40	66.96			
Flood control – reservoirs	26.66	33.30	41.20	82.75	101.65	112.08	30.60	34.34	39.83	59.07	63.40	66.96			
Multipurpose power	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
Rehabilitation – channels and harbors	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
Rehabilitation – locks and dams	21.84	26.65	38.78	78.92	101.40	108.59	27.26	33.09	38.47	54.22	64.00	67.54			
EPA Superfund	19.75	21.00	34.84	76.58	98.70	98.67	24.17	31.96	37.32	48.82	63.10	66.02			
EPA construction grants	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
O&M – channels and harbors	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
O&M – locks and dams	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
O&M – flood control	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
O&M – flood control reservoirs	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
O&M – multi-purpose power	24.92	31.75	41.30	79.91	103.60	112.69	31.29	36.11	50.03	59.15	63.65	67.41			
O&M – channel and harbor improvements	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			
Flood control – EVS & DA	19.75	21.00	34.84	76.58	98.70	98.67	24.17	31.96	37.32	48.82	63.10	66.02			
Flood control – rehabilitation	23.92	32.30	42.72	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06			

Note: The standards are based upon private-sector firms that design projects similar to those included in the fund type. The standards are presented as a percentage of direct labor costs. EVS & DA = emergency water supply and drought assistance.

* Direct labor as a percent of total labor

TABLE 2-9
CONSTRUCTION MANAGEMENT INDIRECT COST RATES FOR COMPARABLE PRIVATE-SECTOR PROJECTS
(Civil works)

Fund type	G&A				Burden				Chargeability*		
	25th	Median	75th	25th	Median	75th	25th	Median	75th	Median	75th
Channels and harbors	81.25%	104.10%	118.50%	30.35%	34.22%	39.62%	59.62%	64.90%	69.06%		
Locks and dams	79.91	103.60	112.69	31.29	36.11	50.03	59.15	63.65	67.41		
Beach erosion control	78.59	99.45	103.11	26.48	32.69	37.98	54.15	63.30	67.51		
Flood control	82.75	101.65	112.08	30.60	34.34	39.83	59.07	63.40	66.96		
Flood control - reservoirs	82.75	101.65	112.08	30.60	34.34	39.83	59.07	63.40	66.96		
Multipurpose power	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
Rehabilitation - channels and harbors	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
Rehabilitation - locks and dams	78.92	101.40	108.59	27.26	33.09	38.47	54.22	64.00	67.54		
EPA Superfund	76.58	98.70	98.67	24.17	31.96	37.32	48.82	63.10	66.02		
EPA construction grants	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
O&M - channels and harbors	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
O&M - locks and dams	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
O&M - flood control	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
O&M - flood control reservoirs	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
O&M - multipurpose power	79.91	103.60	112.69	31.29	36.11	50.03	59.15	63.65	67.41		
O&M - channel and harbor improvements	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		
Flood control - EWS & DA	76.58	98.70	98.67	24.17	31.96	37.32	48.82	63.10	66.02		
Flood control - rehabilitation	81.25	104.10	118.50	30.35	34.22	39.62	59.62	64.90	69.06		

Note: The standards are based upon private-sector firms that provide construction management services for projects similar to those included in the fund type. The standards are presented as a percentage of direct labor costs.

* Direct labor as a percent of total labor

TABLE 2-10
ENGINEERING INDIRECT COST RATES FOR COMPARABLE PRIVATE-SECTOR PROJECTS
(MILCON)

Fund type	Technical/Indirect			G&A			Burden			Chargeability*		
	25th	Median	75th	25th	Median	75th	25th	Median	75th	25th	Median	75th
Family housing - Army	27 15%	34 00%	43 05%	85 28%	98 30%	113 54%	25 49%	33 33%	39 92%	58 96%	64 20%	68 02%
Family housing - Air Force	27 15	34 00	43 05	85 28	98 30	113 54	25 49	33 33	39 92	58 96	64 20	68 02
Foreign military sales	29 39	34 30	39 68	84 25	99 20	105 65	30 85	34 46	40 03	58 51	61 90	64 86
Host nation	25 92	31 20	39 87	78 56	103 10	106 88	32 22	37 99	60 43	58 68	62 40	65 76
MILCON - Army	25 92	31 20	39 87	78 56	103 10	106 88	32 22	37 99	60 43	58 68	62 40	65 76
MILCON - Air Force	25 92	31 20	39 87	78 56	103 10	106 88	32 22	37 99	60 43	58 68	62 40	65 76
MILCON - Army Reserves	25 92	31 20	39 87	78 56	103 10	106 88	32 22	37 99	60 43	58 68	62 40	65 76
MILCON - Other	25 92	31 20	39 87	78 56	103 10	106 88	32 22	37 99	60 43	58 68	62 40	65 76
O&M - Army	25 73	35 33	47 98	81 83	99 93	107 42	27 67	34 84	47 69	57 53	61 93	67 83
O&M - Air Force	25 73	35 33	47 98	81 83	99 93	107 42	27 67	34 84	47 69	57 53	61 93	67 83
Production base support	23 70	34 55	42 43	79 58	101 65	107 22	30 50	35 71	49 54	59 08	62 95	67 38
DERA	24 35	29 20	39 08	80 69	100 67	107 61	28 46	33 55	38 99	55 65	63 30	66 65

Note: The standards are based upon private-sector firms that design projects similar to those included in the fund type. The standards are presented as a percentage of direct labor costs.

* Direct labor as a percent of total labor

TABLE 2-11
CONSTRUCTION MANAGEMENT INDIRECT COST RATES FOR COMPARABLE PRIVATE-SECTOR PROJECTS
(MILCON)

Fund type	G&A			Burden			Chargeability*		
	25th	Median	75th	25th	Median	75th	25th	Median	75th
Family housing - Army	11.0%	40.0%	80.0%	25.0%	33.0%	49.0%	71.0%	75.0%	90.0%
Family housing - Air Force	11.0	40.0	80.0	25.0	33.0	49.0	71.0	75.0	90.0
Foreign military sales	123.0	123.0	289.0	14.0	22.0	33.0	35.0	51.0	51.0
Host nation	49.0	120.0	123.0	22.0	27.0	50.0	51.0	71.0	77.0
MILCON - Army	40.0	100.0	123.0	22.0	27.0	60.0	67.0	75.0	83.0
MILCON - Air Force	40.0	100.0	123.0	22.0	27.0	60.0	67.0	75.0	83.0
MILCON - Army Reserves	45.0	92.0	190.0	21.0	25.0	50.0	41.0	71.0	83.0
MILCON - Other	45.0	100.0	140.0	22.0	33.0	50.0	56.0	75.0	83.0
Q&M - Army	40.0	92.0	123.0	22.0	33.0	50.0	67.0	75.0	83.0
Q&M - Air Force	40.0	92.0	123.0	22.0	33.0	50.0	67.0	75.0	83.0
Production base support	49.0	103.0	123.0	17.0	32.0	46.0	56.0	76.0	77.0
DERA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: The standards are based upon private-sector firms that provide construction management services for projects similar to those included in the fund type. The standards are presented as a percentage of direct labor costs.

* Direct labor as a percent of total labor

CHAPTER 3

A USACE COST-MONITORING STRATEGY

USACE is responsible for the cost of constructing its client's projects as well as the cost of engineering and construction management. The cost of constructing the project can be viewed as a given since most USACE work is done with firm-fixed-price contracts that are competitively bid in accordance with the terms of the Federal Acquisition Regulation (FAR). As long as the construction documents are satisfactory and the procurement is error-free, the costs reflect the existing market conditions for Federal procurements and the rules under which they are made. Engineering and construction management costs, however, can and do vary significantly. It is these controllable costs that USACE should target for its cost-management efforts.

Engineering and construction management costs can be categorized as either direct or indirect, and indirect costs can be further subdivided into burden, technical indirect, and G&A. Because USACE previously did not have firm definitions of direct and indirect costs, the same type cost can be classified as direct in one USACE district and indirect in another. Furthermore, USACE cost components could be easily manipulated by taking advantage of ambiguities in accounting practices and policies by classifying as many costs as possible as direct. Classifying questionable costs as direct has a significant impact on the indirect cost rates since it decreases the numerator while simultaneously increasing the denominator by the same amount (see Figure 3-1), thus generating an almost geometric change in the rate. DRM has developed new policies that it hopes will improve this problem; however, even under the best conditions, indirect cost rates are not likely to reflect the relative cost performance or efficiency of an organization. USACE needs a better method for monitoring cost performance.

THE COST MANAGEMENT FACTOR APPROACH

We believe a more accurate method for comparing relative cost performance is the ratio of engineering or construction management costs to project construction costs. In essence, that ratio is the cost of doing business — the cost of providing a service divided by the cost of constructing the project. We refer to this ratio as the

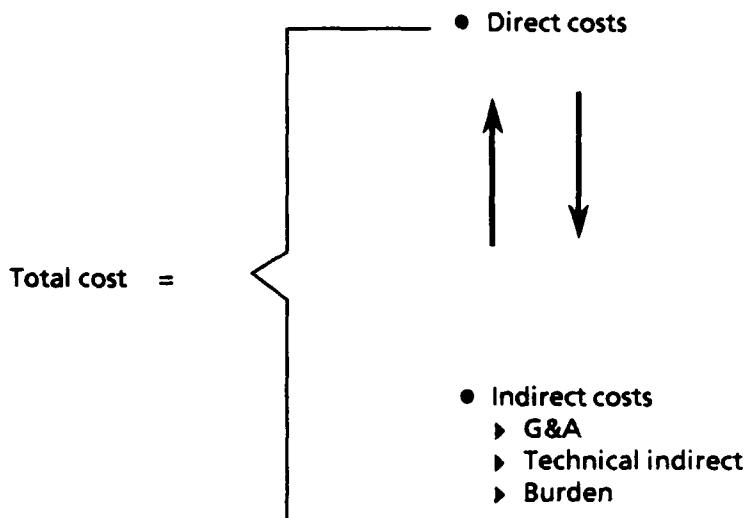


FIG. 3-1. TOTAL COST COMPONENTS

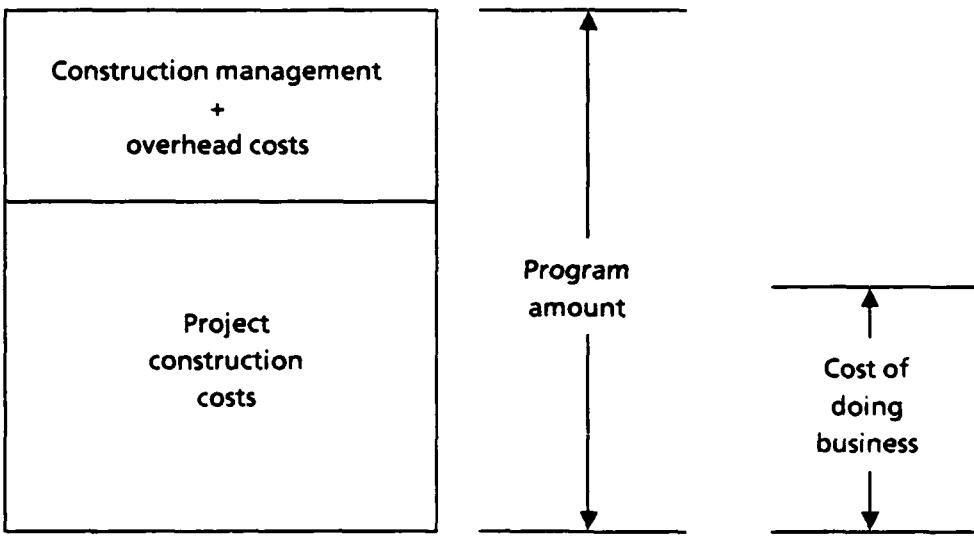
cost management factor (CMF), and its component parts are depicted for construction management in Figure 3-2.

Although the classification of costs is subject to interpretations of accounting practices and policies, accounting for total costs is not as dependent upon interpretation and is much more consistent. Thus, the CMF is a good indicator of actual cost performance, and when compared with an established standard, is an appropriate vehicle for more effective management of these costs.

We have developed CMF standards for USACE MILCON and civil works. Those standards, along with a discussion on how they were developed, are presented in Chapter 4.

INDIRECT COST MANAGEMENT

The CMF approach addresses total costs but does not permit the analysis of indirect costs. We found that indirect costs vary significantly within the construction industry and widely within USACE. We noted that this variance makes using indirect cost rates an ineffective measure of cost performance, and we proposed using the CMF approach as a more appropriate method of managing costs. However, we cannot entirely ignore indirect costs. They must be managed if overall cost performance is to be improved. Districts must be able to assess the reasonableness of



$$\begin{aligned}
 \text{Cost of doing business} &= \text{CMF} \times (\text{construction costs}) \\
 &= \text{Direct } (\$) + \text{indirect } (\$) \\
 &= \text{Direct } (\$) + [\text{T.I.\%} + \text{G\&A\%} + \text{burden \%}] \times \text{direct (labor \$)}
 \end{aligned}$$

Legend:

- T.I.% = Technical indirect
- G&A% = General & administrative
- CMF = Cost management factor
- Burden % = Fringe benefits, etc.
- Direct (\$) = Total direct labor and nonlabor expenses

FIG. 3-2. COST MANAGEMENT FACTOR APPROACH

their indirect costs without feeling the need to justify their rates. They can do that by developing standards for technical indirect, burden, and G&A costs. They should then use those standards to analyze programs, not to evaluate performance. USACE should use total costs through the CMF to evaluate district performance, thereby removing any temptation to use creative accounting to improve indirect costs rates. Over time, this approach should result in indirect cost rates that more closely reflect where money is spent rather than a district's ability to finesse accounting rules.

Indirect cost standards could be developed from either USACE or private sector data. For two reasons, we believe that private sector data provides more meaningful standards. First, the variability of private sector indirect costs is much less than that of the USACE districts. Second, the categorization of indirect costs in the

private sector is subject to much less manipulation than that in USACE since private-sector firms compete on total costs and are seldom evaluated solely on the basis of their indirect cost rates. Thus, we believe that the indirect cost rates shown in Tables 2-8 through 2-11 could be used as USACE indirect cost standards. Those standards could be incorporated into a USACE overhead staffing model that could be used as a tool for assisting district commanders to manage indirect costs.

COST MONITORING AND PERFORMANCE IMPROVEMENT

Different cost management responsibilities exist at districts, divisions, and the USACE headquarters. Headquarters cost managers should be concerned with total program performance. An accurate measure of that performance is the actual weighted average CMF, which is calculated by determining the actual CMF for each type of customer and then weighting those CMFs to reflect the workload for each customer. This calculation ensures that differences in workload mix are recognized and that a district is not penalized simply because its program is dominated by cost intensive projects. A standard weighted average CMF can be calculated in a similar manner using the CMF standards. A district or division's performance can be judged by dividing the actual weighted average by the standard weighted average. This ratio can be used as a index of cost performance. An index value greater than 1.0 indicates that cost goals were not met on aggregate, while a value less than 1.0 indicates cost goals were exceeded. The index is a convenient means of comparing performance since every district could, in theory, have a different standard weighted average CMF. A sample of these calculations is shown in Figure 3-3.

Day-to-day management of programs is a district responsibility, and districts have the most responsibility for cost management. They are concerned with their overall cost performance, their cost performance by category of customer, their indirect cost rates, and project-level costs. At the district, indirect costs and project-level costs are of most importance since it is how well a district manages these costs that ultimately determines USACE's cost competitiveness. Figure 3-4 graphically portrays the cost management hierarchy.

Although districts monitor costs on a project-by-project basis, we believe USACE headquarters and divisions should monitor project costs by examining aggregations of all projects for a particular customer. Project costs can vary because of characteristics of the project that legitimately increase costs or because of

Customer	CMF		Placement (\$ millions)
	Actual ^a	Standard ^b	
MCA	5.7%	5.5%	\$100
MCAF	6.1	6.2	75
OMA	8.0	7.8	90
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

^a The actual rate is the total cost for providing services divided by the total placement.

^b The development of standards is discussed in Chapter 4.

$$\text{Actual weighted average CMF (CMF}_A = \frac{\sum \text{CMF}_A \times \text{placement}}{\text{Total placement}} = \frac{(5.7 \times 100) + (6.1 \times 75) + (8.0 \times 90)}{265}$$

$$= 6.59\%$$

$$\text{Standard weighted average CMF (CMF}_S = \frac{\sum \text{CMF}_S \times \text{placement}}{\text{Total placement}} = \frac{(5.5 \times 100) + (6.2 \times 75) + (7.8 \times 90)}{265}$$

$$= 6.48\%$$

$$\text{CMF index} = \frac{6.59}{6.48} = 1.01$$

FIG. 3-3. CALCULATING PERFORMANCE MEASURES

inefficiencies. Unfavorable variances in individual project costs are generally assumed to be due to project characteristics. Consequently, systematic inefficiencies are rarely highlighted by examining individual projects. When projects are aggregated by customer, however, the variances due to project characteristics tend to cancel each other and systematic inefficiencies are more easily identified by USACE and division managers.

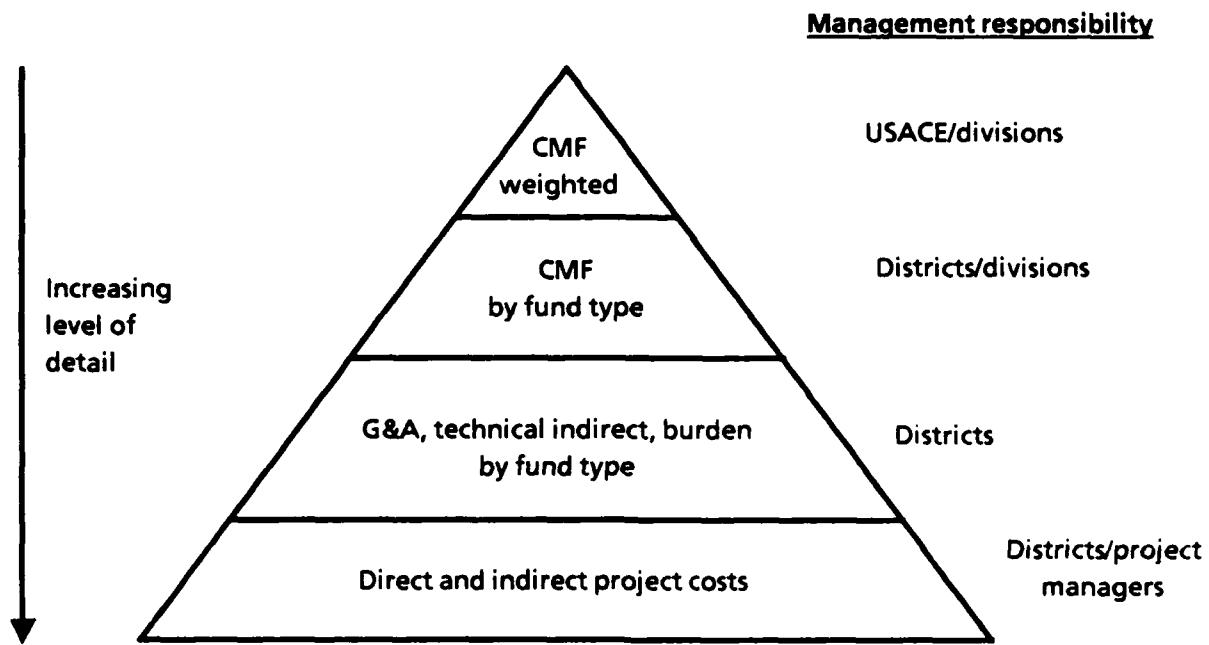


FIG. 3-4. COST MANAGEMENT HIERARCHY

The proposed strategy is to use the CMF as the keystone to a USACE and division management-by-exception policy. If the total cost goal is being met, managers may monitor CMF performance only. If total cost goals are not being met, however, managers would first examine CMF performance by category of customer, then indirect cost performance, and finally project-level costs to identify the problem areas. Divisions and districts should be given total cost performance goals and then be held accountable for meeting them.

Cost performance is ultimately improved by districts decreasing overhead costs or project managers decreasing indirect and direct project costs. USACE headquarters and divisions do not establish district overhead budgets nor do they manage projects, rather they provide policy and direction to districts who implement change. USACE efforts to improve cost performance must recognize these roles.

USACE and divisions can influence cost performance by either of two methods; CMF standards can be lowered based upon management prerogative, or managers and organizations can be encouraged to meet or exceed cost-management goals. In many cases, cost-management goals could be integrated into existing personnel

programs by making them performance objectives for managers. In this way, both positive and negative incentives could be used to influence cost management through an existing system.

CHAPTER 4

ENGINEERING AND CONSTRUCTION MANAGEMENT COST STANDARDS

Establishing cost standards is a key component of cost management. Standards must set a level of performance that meets the needs of the organization, and they must be attainable if they are to be effective yardsticks for measuring performance. A standard that cannot be attained will do little to assist with improving performance. Thus, a standard that, while not ideal, advances the objectives of an organization is more useful than an ideal standard that will soon be ignored.

In establishing the cost standards for engineering and construction management, we started with the premise that standards must be attainable. Standards based upon historic performance are certainly attainable, but do they set the appropriate level of performance? This question is best answered by deciding whether the goal is to have reasonable costs or competitive costs. Reasonable costs are costs that may not be lower on average than those of the private sector but are not sufficiently high to cause concern. For example: if average costs for a certain USACE customer were at the private sector 65th percentile – 35 percent of private sector projects cost more – we would conclude that the costs were reasonable but not necessarily as efficient as they could or should be. Competitive costs, on the other hand, are lower when compared to the private sector average. For example: if average costs for a USACE customer were less than the 50th percentile – 50 percent cost more – we would conclude that the costs were reasonable and competitive since most private sector firms would have charged more for the same services.

USACE's immediate goal should be to establish reasonable costs; its long-term goal should be to develop competitive costs. Thus, establishing cost standards based on historic data meets the immediate cost-performance objective and ensures they are attainable. However, these standards must be recognized as the point of departure for planned improvement. A critical aspect of cost management should be

to improve cost performance through a combination of intensive management and incentives for individuals and organizations.

Tables 4-1 through 4-4 present proposed cost standards for the MILCON and civil works programs. The target rate is the historic median USACE value for that customer when the USACE median does not exceed the private sector 75th percentile. If the USACE median exceeds the private sector 75th percentile, the private sector 75th percentile is used for the target. The range for each customer reflects the variability that is inherent in the type of work and has been estimated from the data available to identify districts whose costs are greater than or lesser than 75 percent of USACE districts. The ends of these ranges should be reevaluated and adjusted during the initial phases of monitoring strategy implementation.

TABLE 4-1
MILITARY ENGINEERING TOTAL COST STANDARDS

Customer	CMF range		
	Low	Target	High
Family housing – Army	4.2%	5.3%	6.4%
Family housing – Air Force	4.6	5.7	6.8
Foreign military sales	2.6	3.3	4.0
Host nation	1.2	1.5	1.8
MILCON – Army	5.7	7.1	8.5
MILCON – Air Force	6.5	8.0	9.6
MILCON – Army Reserves	7.0	8.7	10.4
MILCON – other	6.2	7.8	9.4
O&M – Army	6.6	8.3	10.0
O&M – Air Force	7.4	9.3	11.2
Production base support	7.4	9.3	11.2
DERA	5.6	7.0	8.4

Note: CMFs are expressed as the ratio of total engineering costs to construction contract costs.

TABLE 4-2
MILITARY CONSTRUCTION MANAGEMENT TOTAL COST STANDARDS

Customer	CMF range		
	Low	Target	High
Family housing – Army	4.0%	5.0%	6.0%
Family housing – Air Force	4.2	5.3	6.4
MILCON – Army	4.3	5.4	6.5
MILCON – Air Force	4.9	6.1	7.3
MILCON – Army Reserves	4.2	5.3	6.4
MILCON – other	1.8	2.2	2.6
O&M – Army	6.7	8.4	10.1
O&M – Air Force	7.3	9.1	11.0
Production base support	4.3	5.4	6.5

Note: CMFs are expressed as the ratio of construction management costs to construction contract costs.

TABLE 4-3
CIVIL WORKS ENGINEERING TOTAL COST STANDARDS

Customer	CMF range		
	Low	Target	High
Channels and harbors	5.9%	7.4%	8.9%
Locks and dams	6.4	8.0	9.6
Beach erosion control	5.8	7.3	8.8
Flood control	11.8	14.8	17.8
Flood control – reservoirs	6.9	8.6	10.3
Rehabilitation – channels and harbors	3.8	4.8	5.8
Rehab – locks and dams	6.3	7.9	9.5
EPA Superfund	—	—	—
EPA construction grants	—	—	—
O&M – channels and harbors	3.6	4.5	5.4
O&M – locks and dams	2.3	2.9	3.5
O&M – flood control	2.9	3.6	4.3
O&M – flood control reservoirs	5.1	6.4	7.7
O&M – multipurpose power	3.4	4.2	5.0
O&M – channel and harbor improvements	8.0	10.0	12.0
Recreation	3.3	4.1	4.9
Flood control – rehabilitation	15.8	19.7	23.6
Flood control – construction	9.8	12.3	14.8
Multipurpose power	8.0	10.0	12.0

Note: CMFs are expressed as the ratio of engineering costs to construction contract costs

TABLE 4-4
CIVIL WORKS CONSTRUCTION MANAGEMENT TOTAL COST STANDARDS

Customer	CMF range		
	Low	Target	High
Channels and harbors	4.2%	5.3%	6.4%
Locks and dams	3.8	4.8	5.8
Beach erosion control	3.4	4.3	5.2
Flood control	4.5	5.6	6.7
Flood control – reservoirs	2.6	4.2	5.0
Rehabilitation – channels and harbors	4.2	3.3	4.0
Rehab – locks and dams	--	5.3	6.4
EPA Superfund	--	--	--
EPA construction grants	--	--	--
O&M – channels and harbors	4.6	5.7	6.8
O&M – locks and dams	4.5	5.6	6.0
O&M – flood control	4.2	5.2	6.2
O&M – flood control reservoirs	4.6	5.7	6.8
O&M – multipurpose power	4.6	5.8	7.0
O&M – channel and harbor improvements	5.3	6.6	7.9
Recreation	4.4	5.5	6.6
Flood control – rehabilitation	3.2	4.0	4.8
Flood control – construction	5.4	6.7	8.0
Multipurpose power	2.6	3.3	4.0

Note: CMFs are expressed as the ratio of construction management costs to construction contract costs.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The average charge to USACE MILCON and civil works customers for engineering and construction management is not unreasonable when compared with charges by private-sector firms for similar projects. For MILCON, construction management costs are lower than average private-sector costs while engineering costs are slightly higher. Although few private-sector projects are exactly comparable with USACE civil works projects, USACE civil works costs appear to be reasonable when compared with private-sector projects of similar complexity. However, finding its costs to be reasonable does not imply that engineering and construction management services are being provided as efficiently as they can or should be. We believe that engineering cost performance can and should be improved for both the MILCON and civil works programs if USACE is to remain competitive with private industry. Construction management costs appear to be competitive for the MILCON program and, within the limits of the comparison, for the civil works program.

Indirect cost rates are not effective indicators of overall cost performance. Since the classification of costs is subject to interpretations of practices and policies, indirect cost rates vary significantly in the engineering and construction industries. Those variances are even greater in USACE where the manipulation of indirect cost rates to meet goals has historically distorted the differences between direct and indirect costs. Indirect costs should be monitored as part of overall cost management, but cannot become the sole factor by which cost performance is evaluated.

Historic Headquarters USACE and division cost monitoring efforts have addressed specific problems or relied upon periodic monitoring of indirect cost rates. USACE needs to develop a cost-monitoring strategy that cannot be manipulated. Using a CMF approach based on the total cost of providing services can provide such a strategy. The CMF approach provides an effective way of monitoring and influencing cost performance that is within existing USACE capabilities. A USACE

strategy should incorporate a comparison of actual costs with established standards, a delineation of cost management responsibilities, and methods to improve cost performance. Establishing an effective cost-monitoring strategy is essential if USACE is to maintain its competitiveness with private industry and ensure its customers that they are getting their money's worth.

RECOMMENDATIONS

We recommend that the USACE DRM implement a cost-monitoring strategy based on the total cost of providing engineering and construction management services. The strategy should establish USACE standards for cost performance by type of customer. Existing systems – COEMIS, AMPRS, and PRISM – can provide the information needed for this strategy. Monitoring should occur initially on a quarterly basis with the final monitoring schedule to be determined after initial reviews have been made. Figure 5-1 displays the conceptual framework for a USACE cost-monitoring strategy.

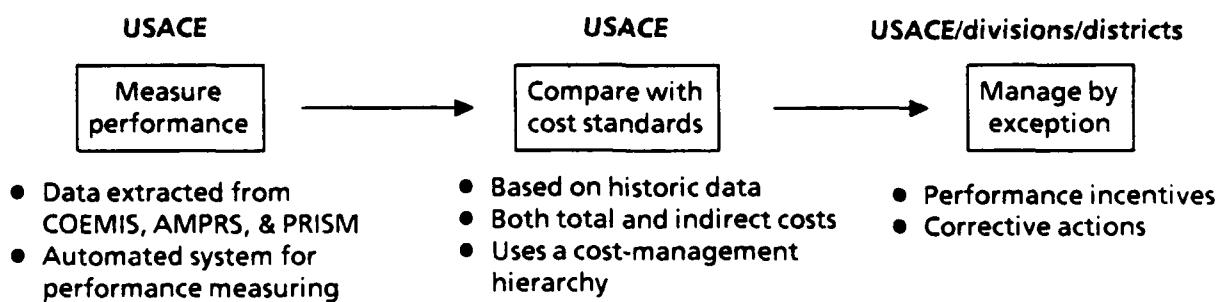


FIG. 5-1. USACE COST-MONITORING STRATEGY

We further recommend that the USACE Chief of Engineers develop a detailed cost management strategy that provides for the implementation of the supporting initiatives identified in Chapter 1. The strategy should be applied beyond engineering and construction management to other functional areas such as planning and operations. The strategy should emphasize and accelerate the development of tools for assisting districts to improve their cost performance, such as a project-level-monitoring strategy and an overhead staffing model.

With the advent of increased local cost sharing for civil works projects and increasing budgetary pressures on the MILCON program, USACE cost performance

will continue to be compared with that of private industry. USACE has cost problems that must be addressed. By adopting an aggressive cost management strategy, USACE can maintain its cost competitiveness in construction management and improve its cost performance in engineering. Failure to ensure cost competitiveness will erode the USACE customer base as noncaptive customers turn to other agencies or the private sector, and could have a significant impact on the USACE engineering and construction program.

APPENDIX A

ESTIMATING ACTUAL USACE CONSTRUCTION MANAGEMENT COSTS WITH THE CERAMMS MODEL

ESTIMATING ACTUAL USACE CONSTRUCTION MANAGEMENT COSTS WITH THE CERAMMS MODEL

The Corps of Engineers Resource and Military Manpower System (CERAMMS) is a computer-based model developed to forecast the manpower required to staff engineering and construction management projects. The model is based upon statistical analysis of more than 10,000 U.S. Army Corps of Engineers' (USACE) design and construction projects. The U.S. Army Manpower Requirements and Documentation Agency (USAMARDA) has reviewed and approved CERAMMS, and it has been used by USACE to forecast requirements and allocate manpower to divisions for the past 2 years.

USACE does not maintain construction management cost records at the project level. Instead, it uses the revolving fund to accumulate earnings and then disburses those earnings to pay the cost of providing construction management services. Earnings are generated by charging customers a fee for each dollar of construction built – this fee is frequently referred to as Supervision and Administration (S&A). The fee is normally the S&A flat rate. For example: \$10 million of Military Construction Army (MCA) placement would generate \$550,000 of earnings.

$$\$10 \text{ million placement} \times 5.5\% \text{ S&A rate} = \$550,000 \text{ earnings}$$

Construction management costs include salaries, rents, overhead expenses, etc. As a result, USACE cannot identify the military program construction management costs specifically associated with any project or class of projects. Despite this shortcoming in the accounting system, it is possible to estimate what those costs are with a relatively high degree of confidence.

The construction management cost is estimated by using actual USACE construction workload for FY88 and FY89 in conjunction with the CERAMMS model. A model output is the number of man-years required to provide construction management services for the placement in a program. The cost of a man-year, including all indirect costs, can be obtained from USACE resource management records. The cost of providing construction management services can then be calculated by multiplying the CERAMMS-provided man-years required by the cost

per man-year from the resource management records. The estimated S&A rate that this would represent can be determined by dividing the cost for construction management services by the placement associated with the requirement.

$$\text{Manyears} \times \text{cost per manyear} = \text{Total cost}$$

$$\frac{\text{Total cost}}{\text{Placement}} = \text{Estimated rate}$$

This estimated rate is then compared with private sector fees. Our experience with the CERAMMS model has shown that it can forecast manpower requirements with an accuracy of ± 5 percent. We believe this methodology can estimate actual construction management costs within the same level of accuracy since manpower costs are approximately 80 percent of the construction management costs for the military program.

APPENDIX B

CIVIL WORKS DATA CALL

CIVIL WORKS DATA CALL

BACKGROUND

Since the U.S. Army Corps of Engineers (USACE) information systems cannot provide adequate engineering and construction management cost data for civil works projects, the USACE had to call upon its divisions and districts for cost data on all civil works projects completed since 1974. The civil works data call was initiated in April 1988 by the Director of Engineering and Construction and the Director of Resource Management. The data sheets and data element definitions from this data call are shown in Tables B-1.

DATA COLLECTION AND ANALYSIS

Data on nearly 1,000 civil works projects were collected from 35 districts and 2 operating divisions. Those data were subjected to a series of manual and computer edits in which blank, duplicate, or invalid projects were deleted; projects with missing, invalid, or extreme values were identified; and the data in question were checked and corrected where necessary. All zero entries were treated as missing values. The resulting analysis sample contained 974 projects.

Corps of Engineers Management Information System (COEMIS) project identification codes and civil works appropriation codes were then used to classify the projects into 17 categories. The classification scheme (see Table B-2) was jointly developed by LMI and USACE and provided a basis for comparisons with military and/or private-sector projects. Figure B-1 shows the number of sample projects in each category.

The cost data were adjusted for inflation. Since data on project costs by year were unavailable, we assumed that total design, planning, architect-engineer (AE) contracting, supervision and review (S&R), engineering and design (E&D), and design-related general and administrative (G&A) costs were incurred at the midpoint of the design phase; and that supervision and administration (S&A), supervision and inspection (S&I), and construction-related G&A costs were incurred at the midpoint of the construction phase. We assumed that the total construction

TABLE B-1
DEFINITION OF DATA ELEMENTS

Note: Include only contracts or portions of projects that are 100 percent physically completed. A project may be split into a number of contracts and each contract can be treated as a separate project for data collection purposes.

1. EROC – Code identifying the District performing the work.
2. Project Description – The name or brief description of the project, such as that used in the AMPRS database.
3. CWIS Number – The Civil Works Identification System number.
4. COEMIS 5-Digit Project Code – The COEMIS project identification code.
5. Civil 3-Digit Category, Class, and Subclass Code – The civil works appropriation code (ER 37-2-10, APP 20-I). Supply all codes if multiple codes apply to one project.
6. Design Start Date – The General Design Memorandum (GDM) approval date.
7. Design Completion Date – The date on which design was completed.
8. Construction Start Date – The date on which construction started following notice to proceed.
9. Construction Completion Date – The date on which construction was physically completed (NOT the date of financial completion).
10. Construction Contract Amount – The final dollar amount of the construction contract, including contingencies and modifications.
11. Design Costs –
 - a. All costs for planning to include reconnaissance and feasibility studies. These are costs included in features 501, 502, 503, and 505 (ER 37-2-10, pp. 8-5a and 8-5b).
 - b. All design costs for GDM and Final Design Memorandum (FDM) preparation as well as any other design costs. These are costs included in features 501, 502, 503, and 505 (ER 37-2-10, pp. 8-5a and 8-5b).
12. AE Contract Amount – The total contracted costs for contracted-out engineering and design effort. Feature 30.1 (ER 37-2-10, p. 8-14).
13. Design Supervision and Review Costs – The costs for supervision and review of contracted-out engineering and design work. Feature 30.2 (ER 37-2-10 pp. 8-14).
14. Direct In-house Engineering and Design Costs – The costs for in-house engineering and design effort. Features 30.4, 30.5, and 30.6 (ER 37-2-10, pp. 8-14 and 8-15).
15. Technical Indirect Engineering and Design Costs – The technical indirect costs for in-house engineering and design effort. Accounting element 232 for features 30.4, 30.5, and 30.6 (ER 37-2-10, pp. 8-14 and 8-15).
16. Construction Supervision and Administration Costs (S&A) – The costs of supervising and administrating construction projects (including supervision and inspection costs). Feature 31 (ER 37-2-10, pp. 8-15 and 8-16).

(Continued)

TABLE B-1
DEFINITION OF DATA ELEMENTS (Continued)

- | | |
|-----|--|
| 17. | Construction Supervision and Inspection Costs (S&I) – The costs of supervising and inspecting construction projects (included in S&A above). Features 31.1 through 31.32 inclusive (ER 37-2-10, pp. 8-15). |
| 18. | General and Administrative Costs (G&A) – The total district overhead costs of the project (for both engineering and construction), not including Area Office overhead. All accounting element 351 costs (excluding Real Estate). |
| 19. | Area Office Overhead – The Area Office overhead costs of the project (use zero if no overhead). All accounting element 352 costs. |
| 20. | Project Location, City – The city or town at or near the project (including 5-digit zip code if available). |
| 21. | Project Location, State – The primary state in which the project is located. |
| 22. | Total Engineering Manhours – The total engineering manhours, including both direct and indirect, spent on the project. Direct hours may be taken from COEMIS, indirect from other sources. |
| 23. | Total Construction Manhours – The total construction manhours, including both direct and indirect, spent on the project. |

contract amount was determined in the construction start year. Once the costs were assigned to specific years, they were converted into 1987 dollars using the 20-city annual average Engineering News Record (ENR) Construction Cost Index.

Finally, we made no adjustments for regional cost differences for four reasons: (1) USACE salaries are not regionally adjusted, (2) regional differences in construction labor costs are minimized by the requirements of the Davis-Bacon Act, (3) construction materials and equipment are frequently not purchased locally, and (4) the analysis of cost ratios rather than absolute costs reduces the impact of any regional variations.

TABLE B-2
PROJECT CATEGORY MAPPING FOR USACE CIVIL WORKS DATA CALL

Project category	Fund types
Channels and harbors	BA - 121 BB - 100,121,21X BE - 21X FW - 216
Locks and dams	BA - 220 BB - 22X BF - 220
Beach erosion control	BA - 140 BB - 410 BC - 400 BD - 140,4XX GM - 400
Flood control	BA - 151,510,511 BB - 230,516 BD - 516,517 BE - 150,151,5XX BG - 511 BJ - 517 FW - 511,516,517
Flood control reservoirs	BB - 520 BC - 520 BD - 520 BE - 152,52X BT - 520
Multipurpose power	BA - 600 BF - 100,160,6XX BK - 600

Note: Two-letter part of fund type is from COEMIS project identification code; 3-digit part of fund type is from civil works appropriation code; and X's refer to all numbers starting with digits shown (e.g., 1XX = 199).

(Continued)

TABLE B-2
PROJECT CATEGORY MAPPING FOR USACE CIVIL WORKS DATA CALL (Continued)

Project category	Fund types
Rehabilitation – channels and harbors	BE - 300 BH - 800,813 BJ - 813
Operations and maintenance – locks and dams	CA - 12X CB - 120
Operations and maintenance – flood control	CA - 100,300,510 CB - 20X,23X-29X
Operations and maintenance – flood control reservoirs	CB - 21X BH - 817 BP - 817
Operations and maintenance – multipurpose power	BH - 818 BP - 818 CC - 210,3XX,510 CG - 300
Operations and maintenance – channel and harbor improvements	CB - 22X CD - 220 CG - 232
Flood control – emergency water system & drought assistance	DD - 4XX
Flood Control – rehabilitation	BH - 516,517 DC - 3XX
Flood control – construction	ER - 32X
Recreation	BG - 711,713,720,770

Note: Two-letter part of fund type is from COEMIS project identification code; 3-digit part of fund type is from civil works appropriation code; and X's refer to all numbers starting with digits shown (e.g., 1XX = 199).

DISTRICT		1 Data Item Number	2 Project (or Contract) Description	3 CWIS Number	4 COEMIS Project Code	5 Civil Code	6 Design Start Date	7 Design Completion Date	8 Construction Start Date
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

FIG. B-1. DATA CALL FORMS

Data Item Number	Construction Completion Date	Construction Contract Amount		Design Costs		A&E Contract Amount		Design S&R Costs		Direct E&D Costs		Tech Indirect E&D Costs		Construction S&A Costs	
		9	10	11	12	13	14	15	16	17	18	19	20	1	2
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

FIG. B-1. DATA CALL FORMS (Continued)

DISTRICT	Data Item Number	Construction S&I Costs	G&A Costs	Area Office Overhead	Project Location (City)	Project Location (Zip)	20	21	22	23
							Total Construction Manhours	Total Engineering Manhours	Project Location (State)	
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

FIG. B-1. DATA CALL FORMS (Continued)

APPENDIX C

PRIVATE-SECTOR CONSTRUCTION MANAGEMENT COSTS

PRIVATE-SECTOR CONSTRUCTION MANAGEMENT COSTS

The construction management industry in the United States is relatively new. In contrast to the engineering industry, it has little data available to validate the fees charged for construction management (CM) services. Until recently, few even agreed on what services constituted construction management. The Construction Management Association of America (CMAA) has recently completed a draft standards of practice manual that describes in detail those services that constitute construction management. In a parallel effort, CMAA also developed and distributed a questionnaire to construction management firms to collect data on the fees charged to provide those services. The collected data are shown at the end of this appendix.

The results of the questionnaire clearly show a wide range in the number of services provided by construction management firms. On average, those firms provide only 80 percent of the services that a full-service company would provide. Thus, before any cost comparison between those firms and the U.S. Army Corps of Engineers (USACE), the fees for any given project must be adjusted to reflect the services provided since the USACE is a full-service organization. The basis for the adjustment was a quantification of the relative costs of providing the construction management services shown in Appendix E. Each private-sector project was brought up to a full-service cost by adding in the costs for missing services as a percentage of the reported costs. The distribution of the adjusted costs was then used in the comparison of USACE construction management costs to those in the private sector.

SURVEY RESPONSES

CMAA distributed the initial survey on 10 March 1988 to 162 members — those companies that perform CM functions. Table C-1 summarizes the response information.

TABLE C-1
SUMMARY OF VALID SURVEY RESPONSES

	Number	Percentage
Companies mailed surveys	162	N/A
Valid company responses	34	21
Valid project responses	162	17 ^a

^a Assumes each company could potentially provide six valid project responses.

GENERAL COMPANY DATA

Table C-2 shows the distribution of valid company responses classified by the company's predominant type of work. Although companies were asked to mark only one choice on the survey, many felt strongly enough to give a dual classification. Most of the respondents — 74 percent — classified themselves as pure construction management companies or a combination of CM and general contractor.

TABLE C-2
DISTRIBUTION BY TYPE OF COMPANY

Company type	No. of respondents	Percentage
A General contractor	0	N/A
B Construction management co.	18	53
C Architect and engineering	3	9
D Other	1	3
A&B General & CM Co.	7	21
A&B&C	1	3
B&C	1	3
No answer	3	9

Note: Percentages do not add to 100 percent because of rounding.

Table C-3 shows the distribution of the valid responses by total staff size. The companies were asked to give a full-time equivalent of the part time and consultant

staff. Most of the responses were from small construction management companies and 78 percent of those companies employed 50 people or fewer.

TABLE C-3
DISTRIBUTION BY COMPANY SIZE

Company size	No. of respondents	Percentage
A 1 - 5	7	21
B 6 - 10	7	21
C 11 - 15	3	9
D 16 - 25	5	15
E 26 - 50	4	12
F 51 - 100	2	6
G 101 - 150	0	N/A
H 151 - 250	1	3
I 251 - 500	1	3
J over 500	1	3
No answer	3	9

Note: Percentages do not add to 100 percent because of rounding.

The distribution by clientele is shown in Table C-4. Companies were classified as having either private-sector or Government clientele if they indicated that 75 percent of their contracts came from those sources. Otherwise, they were said to be mixed. Few of the survey's participants (12 percent) contract most of their work with the Government.

Table C-5 summarizes company data on fees charged by CM companies, CM companies' customers, and the percentage of Government and private-sector contracts. The results indicate that lump-sum-fixed-fee and cost-plus-fixed-fee are the most popular types of contracts that CM companies enter into. They also show that most construction management work in the private sector is for the corporate/industrial, housing, commercial development, corporate/administrative/commercial, and educational/institutional customers.

TABLE C-4
DISTRIBUTION BY CLIENTELE

Classification	No. of respondents	Percentage
Government	4	12
Private sector	22	65
Mixed	6	18
No answer	2	6

Note: Percentages do not add to 100 percent because of rounding.

A more thorough breakdown of revenues by size of company and type of company is presented in Table C-6. Overall, the CM companies surveyed average \$6.2 million in annual revenues and complete seven projects a year. Combined general contractor and CM companies were the largest revenue generators. Architect and engineering (A&E) firms had the greatest number of construction management projects although their projects tend to generate less revenue on a per-project basis probably because they tend to provide fewer services than the pure CM companies.

DIRECT AND INDIRECT COSTS

A summary of direct and indirect costs as a percentage of total CM revenues is presented in Table C-7. The median, 25th percentile, and 75th percentile are shown for all the valid responses. The data are also analyzed by size and type of company. After screening the original data, we found that 21 of the 34 responses appeared reasonable. Where the responses appeared unreasonable, we did not use the data in our analysis.

The results in Table C-7 provide an indication of how the industry allocates direct and indirect CM costs. As expected, the way each company allocates its costs varies widely. However, the median responses indicate that most companies allocate about half of their costs to direct labor, about 25 percent to general and administrative (G&A) expenses and labor, about 15 percent to payroll burden, and about 10 percent to nonlabor indirect expenses. The size and type of company had little

TABLE C-5
GENERAL COMPANY DATA

Company data	Percentage
1. Types of fees charged by construction management company	
a. Fixed fee	45
(1) Lump sum	29
(2) Cost plus	2
b. Time spent (with maximum or time & materials)	12
c. Percentage of construction contract	12
d. Other	2
2. Types of customers for whom construction management companies provide services	
a. Health care providers	5
b. Corporate/industrial	18
c. Housing/lodging	14
d. Commercial developers	13
e. Corporate/administrative/ commercial	20
f. Educational/institutional	15
g. Private religious/cultural	3
h. State and local government	7
i. Environmental Protection Agency	1
j. Transportation departments	3
k. Department of Defense	1
3. Percentage of government vs. private-sector clientele	
a. Government clients	23
b. Private-sector clients	77

effect on the results except that companies larger than 15 people seemed to have a lower percentage of direct labor costs.

PROJECT DATA

In the last part of the survey, the participants were asked to submit information on at least six individual projects for which their company had performed CM services. The survey asked for type, geographic location, and scope (new construction or renovation) of the construction project, type of contract (CM as owner's agent or CM provides guaranteed maximum price), the basis for internally

TABLE C-6
**SUMMARY OF ANNUAL REVENUES FROM CONSTRUCTION
MANAGEMENT PROJECTS**

	Average annual CM revenues (\$)	Average no. projects
Overall	\$ 6,207,454	7
Size of Company (1)		
A 1 - 5	2,688,333	6
B 6 - 10	1,640,021	8
C 11 - 15	717,867	4
D 16 - 25	12,703,929	8
E 26 - 50	4,264,667	4
F 51 - 100	6,875,000	26
G Over 100	18,779,666	6
Unknown	\$ 12,000,000	2
Type of Company (2)		
A General contractor	N/A	N/A
B Construction Management Co.	\$ 4,151,970	5
C A&E firm	1,183,333	12
A&B	12,842,800	6
A&B&C	4,000,000	3
B&C	7,996,000	8
Unknown	\$ 12,000,000	2

estimating the CM contract value, and the value of the CM and construction contracts.

Table C-8 shows the distribution of the 162 valid projects by geographic location of the construction site. The information indicates that CMAA members perform most of their CM work in the northeast, south, and midwest United States. Table C-9 shows the states located in the listed regions.

TABLE C-7
SUMMARY OF DIRECT AND INDIRECT CM COSTS
(As a % of CM revenues)

	Direct labor expenses			Payroll burden			G&A labor expenses			G&A nonlabor expenses			Nonlabor indirect expenses			Number of companies
	25th	Median	75th	25th	Median	75th	25th	Median	75th	25th	Median	75th	25th	Median	75th	
Overall	30	39	50	6	14	19	6	10	13	7	10	17	3	5	10	21
Size of company																
1 - 15	30	40	55	9	15	20	5	10	12	5	12	20	3	5	10	13
Over 15	22	27	41	6	11	15	10	11	14	8	10	12	3	5	10	8
Type of company																
Gen. contractor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
CM company	33	41	53	6	15	19	5	9	10	7	10	17	3	5	6	11
All other	22	30	50	10	13	16	10	11	14	10	11	18	3	8	12	10

TABLE C-8
DISTRIBUTION OF PROJECTS BY GEOGRAPHIC REGION

Region	No. of projects	Percentage
Northeast	60	37
South	44	27
Midwest	33	20
Southwest	7	4
Mountain	3	2
West	9	6
Other	1	1
Unknown	5	3

TABLE C-9
BREAKDOWN OF GEOGRAPHIC REGIONS BY STATES

Region	States
Northeast	CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT
South	AR, AL, DC, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV
Midwest	IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI
Southwest	AZ, NM, OK, TX
Mountain	CO, ID, MT, NV, WY, UT
West	AK, CA, HI, OR, WA
Other	Canada, Mexico, and overseas

Table C-10 shows the distribution of the 162 valid responses by project type. It indicates the specific types of construction projects for which CM services were provided.

The 49 types of construction projects were aggregated into fund type categories. Table C-11 shows how the various types of construction tasks were grouped into construction categories for this purpose. The projects were grouped by similarities in the type of construction management performed for the various construction types within the general customer headings.

Table C-12 is a summary of the CM fees for all projects by size of company, type of company, and client base. This analysis supports the earlier statement that the CM fee is not affected by the size of the company. However, Table C-12 indicates that the pure CM companies are providing CM services at the least cost regardless of the type of construction project. Also, CM companies providing services primarily for the government are doing so at a lower cost than those CM companies providing services primarily for the private sector.

PROJECT STATISTICS SUMMARIES

Project statistics for each construction category (USACE customer) are shown in Tables C-13 through C-26. Each table provides the following information:

- *The Construction Management Fee as a Percentage of Construction Contract.* The construction management fee is presented as a percentage of the value of the construction contract. For instance, for each construction type category, the CM fee is given for the following elements:
 - ▶ All project
 - ▶ CM as owner's agent contracts
 - ▶ CM provides guaranteed maximum price contracts
 - ▶ Renovation projects
 - ▶ New construction projects.

TABLE C-10
DISTRIBUTION OF VALID RESPONSES BY PROJECT TYPE

Type of project	No. of respondents	Percentage
Health care providers		
(01) Hospitals	3	2%
(03) Clinics/outpatient facilities	3	2
(04) Medical offices	5	3
(05) Extended care/nursing homes	1	1
Corporate/industrial		
(06) Warehouse/distribution centers	10	6
(07) Light industrial	2	1
(08) Process plants/heavy industrial	10	6
Housing/lodging		
(09) Hotels (high rise)	3	2
(10) Motels (low rise)	1	1
(11) Apts./condos. (high rise)	3	2
(12) Apts./condos. (low rise)	12	7
(13) Single-family housing	7	4
Commercial developers		
(14) High-rise office bldgs.	5	3
(15) Mid-rise office bldgs.	8	5
(16) Low-rise office bldgs.	7	4
(17) Shopping malls (enclosed)	1	1
(18) Strip shopping centers	3	2
Corporate/administrative/commercial		
(19) General offices	14	9
(20) Retail stores	7	4
(21) Restaurants	1	1%

Notes: Percentages may not add to 100 percent because of rounding. Two-digit code refers to CMAA Survey project type.

(Continued)

TABLE C-10
DISTRIBUTION OF VALID RESPONSES BY PROJECT TYPE (Continued)

Type of project	No. of respondents	Percentage
Educational/institutional		
(22) Classrooms	17	10
(23) Science/research labs	2	1
(24) Dormitories/housing	3	2
(25) Sports/athletic facilities	4	2
Private religious/cultural		
(26) Churches	3	2
(27) Theaters/auditoriums	4	2
State and local government		
(28) Office buildings	3	2
(29) Museums/galleries	1	1
(30) Correctional facilities	4	2
Environmental Protection Agency		
(31) Water treatment plants	0	N/A
(32) Wastewater treatment	0	N/A
(33) Hazardous waste facilities	0	N/A
(34) Water/sewer lines	0	N/A
Transportation departments		
(35) Bridges	3	2
(36) Roads	3	2
(37) Tunnels	1	1
(38) Airports	0	N/A
Department of Defense		
(39) Military housing	0	N/A
(40) Military offices	1	1
(41) Military training facilities	1	1
(42) Military medical facilities	0	N/A
(43) Piers/wharfs	0	N/A
(44) Dredging	0	N/A
(45) Locks and dams	0	N/A
(46) Reservoirs	0	N/A
(47) Channel protection	0	N/A
(48) Beach stabilization	0	N/A

Note: Two-digit code refers to CMAA Survey project type.

(Continued)

TABLE C-10
DISTRIBUTION OF VALID RESPONSES BY PROJECT TYPE (Continued)

Type of project	No. of respondents	Percentage
Other Federal		
(49) Office buildings	0	N/A
(50) Postal facilities	1	1
No answer	5	3

Notes: Percentages may not add to 100 percent because of rounding.

Two-digit code refers to CMAA Survey project type.

For each of these conditions, the 25th percentile, median, 75th percentile, and the number of individual projects in the analysis are given. The number of different companies providing the project information is also given to indicate whether the information provided is unique to a single company or whether the data are the result of several different companies' projects. The CM fee ranges indicate what the competition is charging and can be used as the starting point to determine an appropriate CM fee for the various types of construction and conditions. Where an N/A is given, too few data points were available to meaningfully consider the 25th and 75th percentile statistics.

The analysis in this section assumes that there is no significant difference in fees charged by various sizes and types of companies. While the geographic location of the project may affect the CM fee, that factor was not analyzed in this study.

Following each table, the average value of the construction and CM contracts that comprised the CM fee analysis is shown.

- **Basis for Estimating CM Contract Value.** This section of each table shows the methods used by the participants of the survey in determining what fee will be charged. Percent of construction contract value, direct and indirect cost calculation, or other may be selected. This information merely provides a means to compare the competition's methods.
- **Summary of CM Services.** Each table also shows a summary of the CM services provided for the projects included in the construction category. The types of services are defined in the *CMAA Standards of Practices Manual*.

TABLE C-11
MAPPING OF PRIVATE SECTOR PROJECT TYPES TO CORPS OF ENGINEERS FUND TYPES

USACE fund types	Project types
Military construction	
Family housing – Army	(11) Apartment/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing
Family housing – Air Force	(11) Apartment/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing
Foreign military sales	(07) Light industrial (28) Office buildings (38) Airports (40) Military offices (41) Military training facilities (42) Military medical facilities
Host nation	(01) Hospitals (07) Light industrial (24) Dormitories/housing (25) Sports/athletic facilities (28) Office buildings (31) Water treatment plants (36) Roads (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings
MILCON – Army	(01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitory/housing (25) Sports/athletic fields (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (34) Water/sewer lines

Note: The two digit number in parentheses refers to the CMAA survey project category code.

(Continued)

TABLE C-11

MAPPING OF PRIVATE SECTOR PROJECT TYPES TO CORPS OF ENGINEERS FUND TYPES
(Continued)

USACE fund types	Project types
MILCON – Army (continued)	(39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities
MILCON – Air Force	(01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitory/housing (25) Sports/athletic fields (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (34) Water/sewer lines (38) Airports (39) Military housing (42) Military training facilities (42) Military medical facilities
MILCON – Army Reserves	(16) Low-rise office buildings (22) Classrooms (49) Federal office buildings
MILCON – other	(04) Medical office (06) Warehouse/distribution centers (07) Light industrial (08) Process plants/heavy industrial (11) Apartments/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing (14) High-rise office buildings (15) Mid-rise office buildings (20) Retail stores (22) Classrooms (23) Science research labs (24) Dormitory/housing

Note: The two digit number in parentheses refers to the CMAA survey project category code.

(Continued)

TABLE C-11

MAPPING OF PRIVATE SECTOR PROJECT TYPES TO CORPS OF ENGINEERS FUND TYPES
(Continued)

USACE fund types	Project types
MILCON – other (Continued)	<ul style="list-style-type: none"> (25) Sports/athletic fields (26) Churches (27) Theaters/auditoriums (28) Office buildings (29) Museums/galleries (30) Correctional facilities (31) Water treatment plants (32) Wastewater treatment (33) Hazardous waste facilities (34) Water/sewer lines (35) Bridges (36) Roads (37) Tunnels (38) Airports (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings (50) Postal facilities
Operations & maint. – Army	<p>All renovation projects for the following:</p> <ul style="list-style-type: none"> (01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (08) Process plants/heavy industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitory/housing (25) Sports/athletic fields (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (34) Water/sewer lines (36) Roads (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings

Note: The two digit number in parentheses refers to the CMAA survey project category code.

(Continued)

TABLE C-11

**MAPPING OF PRIVATE SECTOR PROJECT TYPES TO CORPS OF ENGINEERS FUND TYPES
(Continued)**

USACE fund types	Project types
Operations & maint. – Air Force	All renovation projects for the following: (01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (08) Process plants/heavy industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitory/housing (25) Sports/athletic fields (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (33) Hazardous waste facilities (34) Water/sewer lines (36) Roads (38) Airports (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings
Production base support	(06) Warehouse/distribution centers (08) Process plants/heavy indust. (33) Hazardous waste facilities (34) Water/sewer lines (36) Roads (49) Federal office buildings
Defense Env. Restor. Act	(31) Water-treatment plant (32) Wastewater treatment (33) Hazardous waste facility (34) Water/sewer lines
Other	(04) Medical offices (14) High-rise office buildings (20) Retail stores (26) Churches (50) Postal facilities

Note: The two digit number in parentheses refers to the CMAA survey project category code.

TABLE C-12
SUMMARY OF CONSTRUCTION MANAGEMENT FEE RATES
(As a percent of construction contract)

	Construction management fee			No. of projects	No. of companies
	25th	Median	75th		
Overall	3.7	5.0	7.2	159	34
Size of company					
1 - 5	3.1	5.0	8.5	33	7
6 - 10	4.6	6.0	9.0	33	7
11 - 15	2.9	5.3	7.5	8	3
16 - 25	4.0	5.5	7.0	29	5
26 - 50	3.4	4.5	5.2	20	4
51 - 100	2.7	4.8	7.1	12	2
Over 100	2.9	4.9	7.0	23	3
No answer				3	3
Type of company					
A. General contractor	N/A	N/A	N/A	0	0
B. Construction management firm	3.3	5.0	6.6	86	18
C. A&E firm	4.3	6.0	9.6	18	3
D. Other	N/A	3.4	N/A	6	1
A&B	3.8	5.0	6.9	37	7
A&B&C	N/A	8.1	N/A	6	1
B&C	N/A	12.7	N/A	6	1
Unknown				3	3
Client Base					
Government	1.9	4.3	6.9	24	4
Private sector	4.2	5.7	8.0	105	22
Mixed	3.0	4.0	6.0	31	6
No answer				2	2

TABLE C-13

FAMILY HOUSING – ARMY

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	4.5	5.0	5.3	12	10
CM as owner's agent	3.8	5.0	5.3	10	8
CM provides guaranteed max price	N/A	7.9	N/A	2	2
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	4.5	5.0	5.3	12	10

Average Value of Construction Contract \$ 6,091,667
Average Value of CM Contract \$ 305,167

Basis for Estimating CM Contract Value

	Percent of Construction Contract Value	50%
Direct and Indirect Cost Calculation		33%
Other		17%

Summary of Construction Management Services

Predesign Phase Services

Project Management	67%
Scheduling	67%
Cost Management	67%
Contract/Project Administration	67%

Design and Bid Phase Services

Project Management	83%
Scheduling	83%
Contract/Project Administration	83%

Construction Phase Services

Project Management	92%
Scheduling	92%
Cost Management	92%
Contract/Project Administration	92%
Quality Assurance	100%

Additional Services

Procurement of Materials	58%
Value Engineering	75%
Cost Estimating	92%
Constructability Review	92%
Materials Testing	50%
Claims Analysis	17%
Other	17%

TABLE C-14
FAMILY HOUSING – AIR FORCE
CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	4.5	5.0	5.3	12	10
CM as owners agent	3.8	5.0	5.3	10	8
CM provides guaranteed max price	N/A	7.9	N/A	2	2
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	4.5	5.0	5.3	12	10

Average Value of Construction Contract \$ 6,091,667
Average Value of CM Contract \$ 305,167

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	50%
Direct and Indirect Cost Calculation	33%
Other	17%

Summary of Construction Management Services

Predesign Phase Services

Project Management	67%
Scheduling	67%
Cost Management	67%
Contract/Project Administration	67%

Design and Bid Phase Services

Project Management	83%
Scheduling	83%
Contract/Project Administration	83%

Construction Phase Services

Project Management	92%
Scheduling	92%
Cost Management	92%
Contract/Project Administration	92%
Quality Assurance	100%

Additional Services

Procurement of Materials	58%
Value Engineering	75%
Cost Estimating	92%
Constructability Review	92%
Materials Testing	50%
Claims Analysis	17%
Other	17%

TABLE C-15
FOREIGN MILITARY SALES
CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.7	5.0	6.0	5	3
CM as owner's agent	N/A	4.3	N/A	4	3
CM provides guaranteed max price	N/A	12.0	N/A	1	1
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.7	5.0	6.0	5	3

Average Value of Construction Contract	\$ 193,300,000
Average Value of CM Contract	\$ 1,270,000

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	20%
Direct and Indirect Cost Calculation	80%
Other	0%

Summary of Construction Management Services

Predesign Phase Services

Project Management	80%
Scheduling	40%
Cost Management	40%
Contract/Project Administration	40%

Design and Bid Phase Services

Project Management	80%
Scheduling	60%
Contract/Project Administration	60%

Construction Phase Services

Project Management	100%
Scheduling	80%
Cost Management	80%
Contract/Project Administration	80%
Quality Assurance	60%

Additional Services

Procurement of Materials	20%
Value Engineering	40%
Cost Estimating	40%
Constructability Review	20%
Materials Testing	20%
Claims Analysis	20%

TABLE C-16
HOST NATION
T FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.7	6.0	7.5	13	9
CM as owner's agent	3.1	5.0	6.6	11	8
CM provides guaranteed max price	N/A	9.8	N/A	2	2
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.7	6.0	7.5	13	9

Average Value of Construction Contract \$ 117,010,000
Average Value of CM Contract \$ 5,353,462

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	15%
Direct and Indirect Cost Calculation	77%
Other	8%

Summary of Construction Management Services

Predesign Phase Services

Project Management	62%
Scheduling	54%
Cost Management	46%
Contract/Project Administration	54%

Design and Bid Phase Services

Project Management	85%
Scheduling	77%
Contract/Project Administration	74%

Construction Phase Services

<u>Project Management Services</u>	
Project Management	85%
Scheduling	92%
Cost Management	77%
Contract/Project Administration	92%
Quality Assurance	77%

Additional Services

Procurement of Materials	15%
Value Engineering	46%
Cost Estimating	69%
Constructability Review	46%
Materials Testing	23%
Claims Analysis	38%

TABLE C-17

MILCON - ARMY

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.7	5.0	6.7	38	20
CM as owner's agent	3.5	5.0	6.5	31	15
CM provides guaranteed max price	3.8	7.5	15.0	7	7
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.7	5.0	6.7	38	20

Average Value of Construction Contract \$ 50,131,211
Average Value of CM Contract \$ 1,340,066

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	34%
Direct and Indirect Cost Calculation	47%
Other	18%

Summary of Construction Management Services

Predesign Phase Services

Service	Offered
Project Management	74%
Scheduling	66%
Cost Management	71%
Contract/Project Administration	66%

Design and Bid Phase Services

Project Management	87%
Scheduling	95%
Contract/Project Administration	92%

Construction Phase Services

Project Management	97%
Scheduling	89%
Cost Management	87%
Contract/Project Administration	89%
Quality Assurance	79%

Additional Services

Procurement of Materials	45%
Value Engineering	63%
Cost Estimating	82%
Constructability Review	66%
Materials Testing	32%
Claims Analysis	21%
Other	5%

TABLE C-18

MILCON - AIR FORCE

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.7	5.0	5.7	38	20
CM as owner's agent	3.5	5.0	6.5	31	15
CM provides guaranteed max price	3.5	7.5	15.0	7	7
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.7	5.0	5.7	38	20

Average Value of Construction Contract \$ 50,131,211
Average Value of CM Contract \$ 1,340,066

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	34%
Direct and Indirect Cost Calculation	47%
Other	18%

Summary of Construction Management Services

Predesign Phase Services

Project Management	74%
Scheduling	66%
Cost Management	71%
Contract/Project Administration	66%

Design and Bid Phase Services

Project Management	87%
Scheduling	95%
Contract/Project Administration	92%

Construction Phase Services

Project Management	97%
Scheduling	89%
Cost Management	87%
Contract/Project Administration	89%
Quality Assurance	79%

Additional Services

Procurement of Materials	45%
Value Engineering	63%
Cost Estimating	82%
Constructability Review	66%
Materials Testing	32%
Claims Analysis	21%
Other	5%

TABLE C-19

MILCON - ARMY RESERVES

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CM fee			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.9	6.3	7.1	15	9
CM as owner's agent	3.9	6.0	6.9	13	8
CM provides guaranteed max price	N/A	7.4	N/A	2	2
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.9	6.3	7.1	15	9

Average Value of Construction Contract \$ 6,933,333
Average Value of CM Contract \$ 212,919

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	53%
Direct and Indirect Cost Calculation	27%
Other	20%

Summary of Construction Management Services

Predesign Phase Services

Project Management	80%
Scheduling	87%
Cost Management	87%
Contract/Project Administration	80%

Design and Bid Phase Services

Project Management	87%
Scheduling	93%
Contract/Project Administration	93%

Construction Phase Services

Project Management	93%
Scheduling	93%
Cost Management	93%
Contract/Project Administration	93%
Quality Assurance	87%

Additional Services

Procurement of Materials	53%
Value Engineering	60%
Cost Estimating	67%
Constructability Review	93%
Materials Testing	40%
Claims Analysis	13%

TABLE C-20
MILCON - OTHER
CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	3.7	5.0	7.0	77	26
CM as owner's agent	3.1	5.0	6.5	63	23
CM provides guaranteed max price	4.0	7.3	11.1	14	8
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	3.7	5.0	7.0	77	26

Average Value of Construction Contract \$ 40,500,922
Average Value of CM Contract \$ 1,698,236

<u>Basis for Estimating CM Contract Value</u>	
Percent of Construction Contract Value	40%
Direct and Indirect Cost Calculation	40%
Other	19%

Summary of Construction Management Services

Predesign Phase Services

Project Management	71%
Scheduling	70%
Cost Management	70%
Contract/Project Administration	70%

Design and Bid Phase Services

Project Management	82%
Scheduling	82%
Contract/Project Administration	84%

Construction Phase Services

Project Management	92%
Scheduling	95%
Cost Management	86%
Contract/Project Administration	96%
Quality Assurance	84%

Additional Services

Procurement of Materials	51%
Value Engineering	62%
Cost Estimating	81%
Constructability Review	74%
Materials Testing	38%
Claims Analysis	25%
Other	5%

TABLE C-21

OPERATIONS & MAINTENANCE – ARMY

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	4.2	5.1	7.1	28	17
CM as owner's agent	4.0	5.0	7.0	25	16
CM provides guaranteed max price	N/A	7.2	N/A	3	2
Renovation	4.2	5.1	7.1	28	17
New construction	N/A	N/A	N/A	N/A	N/A

Average Value of Construction Contract \$ 26,414,464
Average Value of CM Contract \$ 1,252,620

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	29%
Direct and Indirect Cost Calculation	46%
Other	25%

Summary of Construction Management Services

Predesign Phase Services

Project Management	68%
Scheduling	57%
Cost Management	64%
Contract/Project Administration	61%

Design and Bid Phase Services

Project Management	82%
Scheduling	89%
Contract/Project Administration	86%

Construction Phase Services

Project Management	93%
Scheduling	93%
Cost Management	82%
Contract/Project Administration	89%
Quality Assurance	79%

Additional Services

Procurement of Materials	46%
Value Engineering	61%
Cost Estimating	82%
Constructability Review	68%
Materials Testing	25%
Claims Analysis	39%

TABLE C-22

OPERATIONS & MAINTENANCE – AIR FORCE

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	4.2	5.1	7.1	28	17
CM as owner's agent	4.0	5.0	7.0	25	16
CM provides guaranteed max price	N/A	7.2	N/A	3	2
Renovation	4.2	5.1	7.1	28	17
New construction	N/A	N/A	N/A	N/A	N/A

Average Value of Construction Contract \$ 26,414,464
Average Value of CM Contract \$ 1,252,620

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	29%
Direct and Indirect Cost Calculation	46%
Other	25%

Summary of Construction Management Services

Predesign Phase Services

Design Phase Services	Percentage
Project Management	68%
Scheduling	57%
Cost Management	64%
Contract/Project Administration	61%

Design and Bid Phase Services

Project Management	82%
Scheduling	89%
Contract/Project Administration	86%

Construction Phase Services

Project Management	93%
Scheduling	93%
Cost Management	82%
Contract/Project Administration	89%
Quality Assurance	79%

Additional Services

Procurement of Materials	46%
Value Engineering	61%
Cost Estimating	82%
Constructability Review	68%
Materials Testing	25%
Claims Analysis	39%

TABLE C-23
PRODUCTION BASE SUPPORT
CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	2.9	4.3	6.5	15	9
CM as owner's agent	2.9	4.5	6.5	14	8
CM provides guaranteed max price	N/A	3.8	N/A	1	1
Renovation	N/A	N/A	N/A	N/A	N/A
New construction	2.9	4.3	6.5	15	9

Average Value of Construction Contract \$ 96,051,667
Average Value of CM Contract \$ 5,735,000

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	27%
Direct and Indirect Cost Calculation	60%
Other	13%

Summary of Construction Management Services

Predesign Phase Services

	40%
Project Management	33%
Scheduling	40%
Cost Management	33%
Contract/Project Administration	33%

Design and Bid Phase Services

Project Management	60%
Scheduling	73%
Contract/Project Administration	73%

Construction Phase Services

Function	Percentage
Project Management	87%
Scheduling	100%
Cost Management	73%
Contract/Project Administration	100%
Quality Assurance	80%

Additional Services

Service	Percentage
Procurement of Materials	40%
Value Engineering	33%
Cost Estimating	60%
Constructability Review	67%
Materials Testing	40%
Claims Analysis	40%
Other	7%

TABLE C-24

DEFENSE ENVIRONMENT RESTORATION PROGRAM

CONSTRUCTION MANAGEMENT FEE AS PERCENTAGE OF CONSTRUCTION COST

	CMF			No. of projects in analysis	No. of companies
	25%	Median	75%		
Overall fee	N/A	N/A	N/A	0	0
CM as owner's agent					
CM provides guaranteed max price					
Renovation					
New construction					

Average Value of Construction Contract

Average Value of CM Contract

Basis for Estimating CM Contract Value

Percent of Construction Contract Value	%
Direct and Indirect Cost Calculation	%
Other (Cost-plus Fee)	%
Other (Project Duration Calculation)	%

Summary of Construction Management Services

Predesign Phase Services

Project Management	7%
Scheduling	6%
Cost Management	5%
Contract/Project Administration	4%

Design and Bid Phase Services

Project Management	%
Scheduling	%
Contract/Project Administration	%

Construction Phase Services

Project Management	%
Scheduling	%
Cost Management	%
Contract/Project Administration	%
Quality Assurance	%

Additional Services

Procurement of Materials	%
Value Engineering	%
Cost Estimating	%
Constructability Review	%
Materials Testing	%
Claims Analysis	%

APPENDIX D

ADJUSTMENT OF ENGINEERING COSTS

ADJUSTMENT OF ENGINEERING COSTS

INTRODUCTION

A comparison of customer costs for organizations providing engineering services must address differences in the scope of the services provided. Failure to do so can lead to misleading or erroneous results. Raw cost data must be adjusted if the comparisons are to be meaningful.

COST ADJUSTMENTS

The raw cost data used for comparisons in this study consisted of total engineering costs for various types of projects. Private-sector data were obtained from the Professional Services Management Journal database and comprised accumulations of like projects. The U.S. Army Corps of Engineers (USACE) data were for completed USACE projects.

The first step in making appropriate cost adjustments is to identify all the services that can be provided. We refer to that as the "full-service" listing. The American Institute of Architects has developed a listing of basic services in its AIA Document B141. We have added to that list additional services identified by the Professional Services Management Association in its annual survey of engineering costs. The complete full-service listing is shown in Table D-1.

The next step is to identify how much of the total cost is associated with each of the services. Unfortunately, neither the private sector nor USACE maintains cost accounts at that level of detail. Therefore, we must use a methodology that does not rely entirely on the accounting information available. An analytical technique that lends itself to such a problem is the pair-wise comparison of variables (services) using an analytic hierarchical process (AHP). This technique solicits opinions from experts in a field and then quantifies the opinions through a series of mathematical algorithms. The output of the process is a numerical weighting of the relative importance of the services being examined. The weightings total to 100 percent and, in essence, are that portion of the total cost that can be attributed to each service. Tables D-2 and D-3 show the results of applying this technique to the full listing of

TABLE D-1
FULL-SERVICE LISTING OF ENGINEERING SERVICES

Service
1.0 Predesign services
1.1 Facilities programming
1.2 Site selection/feasibility studies
1.3 Project cost/budget programming
1.4 Environmental impact studies
1.5 Survey of existing facilities
1.6 Zoning/regulatory approvals
2.0 Preliminary/concept design
2.1 Agency approval
2.2 Written reports on design choices
* 2.3 Initial design submittals
2.4 Multiple design submittals
2.5 Energy studies
* 2.6 Budget cost estimates
3.0 Design development
* 3.1 Preparation of drawings
* 3.2 Development of standard specifications
4.0 Construction documents
4.1 Agency approval permits
4.2 Specifications by owner standards
4.3 Cost estimates by system component
4.4 Cost estimates by detail line item
* 4.5 Preparation of bidding documents
5.0 Bidding/negotiation services
* 5.1 Assistance in evaluating bids and negotiations
6.0 Construction period services
* 6.1 Periodic site inspections
6.2 Full-time site representation
6.3 Purchasing of project materials
* 6.4 Shop drawing review
* 6.5 Change order preparation
* 6.6 Verification of pay estimates
* 6.7 Resolution of contract document conflicts

Note: Items marked with an (*) indicate services that are considered to be part of the basic fee for architectural services per AIA Document B141. Other services listed are considered to be in addition to the basic fee.

engineering services for military construction and the civil works program, respectively.

The final step in adjusting engineering costs so they are comparable is to add costs to the raw data to reflect a full-service fee. Generally, USACE divisions and districts provide more engineering services on a per-project basis than their private-sector counterparts. One reason is that USACE is the sole supplier of engineering services to many DoD agencies. USACE's role as sole supplier is in contrast to the private sector where more than one firm may provide engineering services for the same project. Additionally, private-sector firms tend to avoid certain types of services because of the potential liabilities associated with them. USACE, however, is the contracting officer whenever it provides engineering services and it assumes all responsibility for projects it manages. The costs associated with these omitted services must be added to the raw data to make the total engineering costs comparable. Likewise, some services that are performed by engineering firms in the private sector are provided by USACE through construction divisions funded with Supervision and Administration (S&A) money which is not captured in USACE total engineering costs. Examples of such services are full-time site representation, verification of pay estimates, and change-order preparation. The costs associated with these services must be added to total USACE raw data to make them comparable. Meaningful comparisons can be made only after these corrections are made to both private sector and USACE raw data.

TABLE D-2
EXPERT OPINION RESULTS
(Military Construction)

Service	% of total engineering cost
1.0 Predesign services	4.5%
1.1 Facilities programming	2.0
1.2 Site selection/feasibility studies	0.9
1.3 Project cost/budget programming	0.5
1.4 Environmental impact studies	0.4
1.5 Survey of existing facilities	0.5
1.6 Zoning/regulatory approvals	0.2
2.0 Preliminary/concept design	9.8
2.1 Agency approval	0.3
2.2 Written reports on design choices	1.4
2.3 Initial design submittals	2.6
2.4 Multiple design submittals	4.0
2.5 Energy studies	0.7
2.6 Budget cost estimates	0.8
3.0 Design development	48.0
3.1 Preparation of drawings	42.7
3.2 Development of standard specifications	5.3
4.0 Construction documents	8.5
4.1 Agency approval permits	0.3
4.2 Specifications by owner standards	1.0
4.3 Cost estimates by system component	1.8
4.4 Cost estimates by detail line item	4.8
4.5 Preparation of bidding documents	0.6
5.0 Bidding/negotiation services	2.5
5.1 Assistance in evaluating bids and negotiations	2.5
6.0 Construction period services	26.6
6.1 Periodic site inspections	1.4
6.2 Full-time site representation	9.7
6.3 Purchasing of project materials	0.5
6.4 Shop drawing review	7.0
6.5 Change order preparation	4.0
6.6 Verification of pay estimates	0.8
6.7 Resolution of contract document conflicts	3.2
Total	100.0

TABLE D-3
EXPERT OPINION RESULTS
(Civil Works)

Service	% of total engineering cost
1.0 Predesign services	7.6%
1.1 Facilities programming	0.2
1.2 Site selection/feasibility studies	2.8
1.3 Project cost/budget programming	1.0
1.4 Environmental impact studies	2.8
1.5 Survey of existing facilities	0.2
1.6 Zoning/regulatory approvals	0.6
2.0 Preliminary/concept design	12.9
2.1 Agency approval	0.6
2.2 Written reports on design choices	2.2
2.3 Initial design submittals	3.6
2.4 Multiple design submittals	5.4
2.5 Energy studies	0.3
2.6 Budget cost estimates	0.8
3.0 Design development	43.5
3.1 Preparation of drawings	37.3
3.2 Development of standard specifications	6.2
4.0 Construction documents	3.6
4.1 Agency approval permits	0.1
4.2 Specifications by owner standards	0.8
4.3 Cost estimates by system component	0.5
4.4 Cost estimates by detail line item	1.9
4.5 Preparation of bidding documents	0.3
5.0 Bidding/negotiation services	1.8
5.1 Assistance in evaluating bids and negotiations	1.8
6.0 Construction period services	30.5
6.1 Periodic site inspections	1.5
6.2 Full-time site representation	13.8
6.3 Purchasing of project materials	0.6
6.4 Shop drawing review	6.3
6.5 Change order preparation	3.9
6.6 Verification of pay estimates	1.2
6.7 Resolution of contract document conflicts	3.2
Total	100.0

APPENDIX E

**ADJUSTMENT OF CONSTRUCTION
MANAGEMENT COSTS**

ADJUSTMENT OF CONSTRUCTION MANAGEMENT COSTS

INTRODUCTION

In comparing customer costs for organizations providing construction management services as with those that provide engineering service, we must address the differences in the scope of the services. If we fail to do so, our results can be misleading or erroneous.

COST ADJUSTMENTS

The raw cost data used for comparisons in this study consisted of total construction management costs for various types of projects. Private sector data were obtained from the Construction Management Association of America (CMAA) database and comprised accumulations of like projects. The U.S. Army Corps of Engineers (USACE) data were for completed USACE projects.

The first step in making appropriate cost adjustments is to identify all the services that can be provided. We refer to that as the "full-service" listing. The CMAA has developed a listing of basic services in its standards of practice manual.

Construction management in the USACE is divided among four organizational levels: field offices, districts, divisions, and the USACE Headquarters. Only the field offices and districts charge their construction management efforts directly to the customer. Division and USACE Headquarters support is funded from Operations and Maintenance – Army (OMA) appropriations. When comparing the costs to USACE customers with those of the private sector, we must therefore differentiate between the suppliers of the services and the services that are provided. Table E-1 shows the percentage of construction management effort expended for each category of service and Table E-2 shows where construction services are performed. The division and USACE (Corps Headquarters) columns represent free service to the Corps' customers.

The data in Tables E-1 and E-2 were derived by a panel of experts drawn from USACE. We identified where construction management services are performed by developing a consensus of the panel on the services provided by each organization

TABLE E-1
EXPENDITURE OF CONSTRUCTION MANAGEMENT EFFORT

Service phase	Percent of construction management costs
1.0 Predesign	1.0%
1.1 Project management	0.7
1.2 Scheduling	0.1
1.3 Cost management	0.1
1.4 Contract/project admin.	0.1
2.0 Design and bid phase	4.6
2.1 Project management	3.3
2.2 Scheduling	0.7
2.3 Contract/project admin.	0.7
3.0 Construction phase	75.6
3.1 Project management	20.3
3.2 Scheduling	4.9
3.3 Cost management	4.1
3.4 Contract/project admin.	7.0
3.5 Quality assurance	39.3
4.0 Additional	18.7
4.1 Procurement of materials	0.5
4.2 Value engineering	0.9
4.3 Claims analysis	7.2
4.4 Admin. of social programs	1.9
4.5 Labor rates	2.0
4.6 Postconstruction activities	6.2%
Total	100.0%

(see Table E-2). For the expenditure of construction management effort, the panel used an analytical technique which employs pair-wise comparisons of variables (services) using an analytic hierarchical process (AHP). In Table E-2, the four organizational levels involved in construction management are shown as well as the effort expended at each level for each of the categories of service. In Table E-1, the

TABLE E-2
WHERE CONSTRUCTION MANAGEMENT SERVICES ARE PERFORMED

Service phase	Field office	District	Division	USACE
1.0 Predesign	1.0%	95.0%	2.5%	1.5%
1.1 Project management	2.0	93.0	3.0	2.0
1.2 Scheduling	0.0	96.0	3.0	1.0
1.3 Cost management	0.0	97.0	2.0	1.0
1.4 Contract/project admin.	0.0	98.0	2.0	0.0
2.0 Design and bid phase	4.0	92.0	3.0	1.0
2.1 Project management	10.0	84.0	5.0	1.0
2.2 Scheduling	0.0	98.0	2.0	0.0
2.3 Contract/project admin.	0.0	98.0	2.0	0.0
3.0 Construction phase	76.0	20.0	2.0	2.0
3.1 Project management	84.0	15.0	1.0	0.0
3.2 Scheduling	92.0	7.0	0.5	0.5
3.3 Cost management	90.0	8.0	1.0	1.0
3.4 Contract/project admin.	48.0	48.0	2.0	2.0
3.5 Quality assurance	84.0	10.0	2.0	4.0
4.0 Additional	48.0	49.0	2.0	1.0
4.1 Procurement of materials	25.0	75.0	0.0	0.0
4.2 Value engineering	35.0	63.0	2.0	0.0
4.3 Claims analysis	58.0	40.0	1.0	1.0
4.4 Admin. of social programs	10.0	87.0	2.0	1.0
4.5 Labor rates	90.0	10.0	0.0	0.0
4.6 Postconstruction activities	90.0%	8.0%	1.0%	1.0%

alternatives were the categories of service, and the decision was how much construction management effort is expended for each service.

The final step in adjusting construction management costs so they are comparable is to add costs to the raw data to reflect a full-service fee. Generally, USACE divisions and districts provide more construction management services on a per-project basis than their private-sector counterparts. One reason is that USACE

is the sole supplier of construction management services to many DoD agencies. Additionally, private-sector firms tend to avoid certain types of services because of the potential liabilities associated with them. USACE, however, is the contracting officer whenever it provides construction management services and it assumes all responsibility for projects it manages. The costs associated with these omitted services must be added to the raw data to make the total construction management costs comparable.

APPENDIX F

MAPPING OF PRIVATE-SECTOR PROJECTS TO USACE CUSTOMER CATEGORY AND CATEGORIZATION OF USACE CUSTOMERS

TABLE F-1
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector project types to USACE customer category
(Military engineering)

Family housing – Army (12) Apartments/condos (low rise) (13) Single-family housing Family housing – Air Force (12) Apartments/condos (low rise) (13) Single-family housing Foreign military sales N/A Host nation N/A MILCON – Army (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (24) Dormitory/housing (25) Sports/athletic facilities (49) Federal Office buildings MILCON – Air Force (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (24) Dormitory/housing (25) Sports/athletic facilities (49) Federal Office buildings	MILCON – Army Reserves (16) Low-rise office buildings (22) Classrooms (49) Federal office buildings MILCON – other (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (14) High-rise office building (15) Mid-rise office buildings (20) Retail stores (23) Science/research labs (26) Churches (50) Postal facilities Operations and maintenance – Army (08) Process plants/heavy industrial (33) Hazardous waste facilities (34) Water/sewer lines (36) Roads (49) Federal office buildings Operations and maintenance – Air Force (08) Process plants/heavy industrial (33) Hazardous waste facilities (34) Water/sewer lines (36) Roads (49) Federal office buildings
	Production base support (08) Process plants/heavy industrial (33) Hazardous waste facilities (34) Water/sewer lines (36) Roads (49) Federal office buildings Defense Environment Restoration Program (31) Water treatment plants (33) Hazardous waste facilities (34) Water/sewer lines (37) Waste water treatment

Note: Two-digit numbers refer to Construction Management Association of America (CMAA) Survey Project Category code

TABLE F-2
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector project types to USACE customer category
(Military construction)

Family housing – Army (11) Apartments/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing Family housing – Air Force (11) Apartments/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing Foreign military sales (07) Light industrial (28) Office buildings (38) Airports Military Offices (40) Military training facilities (41) Military medical facilities MILCON – Army (42) Military medical facilities (49) Federal office buildings MILCON – Air Force (01) Hospitals (03) Clinics/outpatient facilities (04) Medical office Host nation (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitories/housing Host nation (01) Hospitals (07) Light industrial (24) Dormitories/housing (25) Sports/athletic facilities (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (34) Water/sewer lines	Host nation (Continued) (36) Roads (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities MILCON – Army (Continued) (34) Water/sewer lines (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities MILCON – Air Force (01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitories/housing (25) Sports/athletic facilities (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (34) Water/sewer lines
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Note: Two-digit numbers refer to CMAA Survey Project Category code.

(Continued)

TABLE F-2

PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector project types to USACE customer category
(Military construction) (Continued)

MILCON – Air Force (Continued) <ul style="list-style-type: none"> (38) Airports (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities MILCON – Army Reserves <ul style="list-style-type: none"> (16) Low-rise office buildings (22) Classrooms (49) Federal office buildings MILCON – other <ul style="list-style-type: none"> (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (08) Process plants/heavy industrial (11) Apartments/condos (high rise) (12) Apartments/condos (low rise) (13) Single-family housing (14) High-rise office buildings (15) Mid-rise office buildings (20) Retail stores (22) Classrooms 	MILCON – Other (Continued) <ul style="list-style-type: none"> (23) Science/research labs (24) Dormitories/housing (25) Sports/athletic facilities (26) Churches (27) Theaters/auditoriums (28) Office buildings (29) Museums/galleries (30) Correctional facilities (31) Water treatment plants (32) Wastewater treatment (33) Hazardous waste facilities (34) Water/sewer lines (35) Bridges (36) Roads (37) Tunnels (38) Airports (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings Operations and maintenance – Army <ul style="list-style-type: none"> (01) Hospitals (03) Clinics/outpatient facilities (04) Medical office (06) Warehouse/distribution centers (07) Light industrial (08) Process plants/heavy industrial (10) Motels (low rise) (16) Low-rise office buildings (19) General offices (24) Dormitories/housing (25) Sports/athletic facilities (26) Churches (28) Office buildings (31) Water treatment plants (32) Wastewater treatment (33) Hazardous waste facilities (34) Water/sewer lines (35) Bridges (36) Roads (37) Tunnels (38) Airports (39) Military housing (40) Military offices (41) Military training facilities (42) Military medical facilities (49) Federal office buildings
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Note: Two-digit numbers refer to CMAA Survey Project category code.

(Continued)

TABLE F-2
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector project types to USACE fund type headings
(Military construction) (Continued)

Operations and maintenance – Army (Continued)	Operations and maintenance – Air Force (Continued)
(40) Military offices	(34) Water/sewer lines (36) Roads (38) Airports
(41) Military training facilities	(39) Military housing
(42) Military medical facilities	(40) Military offices
(49) Federal office buildings	(41) Military training facilities
(01) Hospitals	(42) Military medical facilities
(03) Clinics/outpatient facilities	(49) Federal office buildings
(04) Medical offices	
(06) Warehouse/distribution centers	Production base support
(07) Light industrial	(06) Warehouse/distribution centers
(08) Process plants/heavy industrial	(08) Process plants/heavy industrial
(10) Motels (low rise)	(33) Hazardous waste facilities
(16) Low-rise office buildings	(34) Water/sewer lines
(19) General offices	(36) Roads
(24) Dormitories/housing	(49) Federal office buildings
(25) Sports/athletic facilities	
(26) Churches	Defense Environment Restoration Program
(28) Office buildings	(31) Water treatment plants
(31) Water treatment plants	(32) Wastewater treatment
(32) Wastewater treatment	(33) Hazardous waste facilities
(33) Hazardous waste facilities	(34) Water/sewer lines

Note: Two-digit numbers refer to CMIA Survey Project Category code.

TABLE F-3
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector firms to USACE customer category
(Military engineering)

Family housing – Army	Production base support (3) Engineering (sub) (4) Architect/engineering
(1) Architect	
Family housing – Air Force	Defense Environment Restoration Program
(1) Architect	(3) Engineering (prime) (5) Architect/engineering/planning
Foreign military sales	(7) Other
(5) Architect/engineering/planning	
Host nation	Other (7) Other
(4) Architect/engineering	
MILCON – Army	
(4) Architect/engineering	
MILCON – Air Force	
(4) Architect/engineering	
MILCON – other	
(4) Architect/engineering	
Operations and maintenance – Army	
(1) Architect	
(4) Architect/engineering	
(6) Architect/interior design	
Operations and maintenance – Air Force	
(1) Architect	
(4) Architect/engineering	
(6) Architect/interior design	

Note: Single-digit number refers to Professional Services Management Journal (PSMJ) firm code

TABLE F-4
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector firms to USACE customer category
(Civil works planning)

Beach erosion control projects
(2) Engineering (prime)
(3) Engineering (sub)
Channels and harbors
(2) Engineering (prime)
(3) Engineering (sub)
Flood control projects
(2) Engineering (prime)
(3) Engineering (sub)
Locks and dams
(2) Engineering (prime)
(3) Engineering (sub)
Multipurpose power projects
(2) Engineering (prime)
(3) Engineering (sub)

Note: Single-digit number refers to P&M firm code.

TABLE F-5
PRIVATE-SECTOR-TO-USACE MAPPING
Private-sector firms to USACE customer category
(Civil works engineering)

Channels and harbors (2) Engineering (prime) Locks and dams (2) Engineering (prime) (4) Architect/engineering Beach erosion control (3) Engineering (sub) (7) Other Flood control (2) Engineering (prime) (5) Architect/engineering/planning Flood control reservoirs (2) Engineering (prime) (5) Architect/engineering/planning Multipurpose power (2) Engineering (prime) Rehabilitation – channels and harbors (2) Engineering (prime) Rehabilitation – locks and dams (2) Engineering (prime) (7) Other	EPA Superfund (7) Other EPA construction grants (2) Engineering (prime) Operations and maintenance – channels and harbors (2) Engineering (prime) Operations and maintenance – locks and dams (2) Engineering (prime) Operations and maintenance – flood control (2) Engineering (prime) Operations and maintenance – flood control reservoirs (2) Engineering (prime) Operations and maintenance – multipurpose power (2) Engineering (prime) (4) Architect/engineering Operations and maintenance – channel and harbor improvements (2) Engineering (prime) (4) Architect/engineering Flood control – emergency water supplies and drought assistance (7) Other Flood control – rehabilitation (2) Engineering (prime)
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Note: Single-digit number refers to PSM firm code.

TABLE F-6
USACE CUSTOMER CATEGORIES
(Military engineering)

Defense Environment Restoration Program (DERP) (05) Defense Environmental Restoration Act	Foreign Military Sales (FMS) (Continued) (91) Engineer Assistance Program, Saudi Arabia (92) (93) (95)
Family Housing – Army (FHA)	Host Nation (HN) (40) Family Housing, New Construction (42) Family Housing, Line Item Improvement (44) Family Housing, Energy Conservation Investment Program (45) Family Housing, Maintenance and Repair
Family Housing – Air Force (FHAF)	Host Nation (HN) (52) North Atlantic Treaty Organization (76) Government of Japan (77) Government of Korea
Foreign Military Sales (FMS)	MILCON – Army (MCA) (10) Military Construction, Army (11) Military Construction, Army, unspecified minor construction (17) Military Construction, Army National Guard (98) Troop Support Agency, Headquarters (99) Troop Support Agency, Local
Military Assistance Program	MILCON – Air Force (MCAF) (13) Military Assistance Program, Air Force (22) Military Assistance Program, Air Force
Foreign Military Sales	MILCON – Air Force (MCAF) (63) (67) (68) (70) Foreign Military Sales (74) (78) (80) (87) (88) (90)
	 (20) Military Construction, Air Force (21) Military Construction, Air Force Reserve (23) Military Construction, Air Force, Minor Construction (25) Military Construction, Air National Guard (29) Military Construction, Air Force (MX)

Note: Two-digit numbers refer to U.S. Army Corps of Engineers (USACE) fund type code.

(Continued)

TABLE F-6
USACE CUSTOMER CATEGORIES
(Military engineering) (Continued)

MILCON - Army Reserves (MCAR)	Other (Continued)
(12) Military Construction, Army Reserve	(49) Operations and Maintenance DoD
Operations and Maintenance - Army (OMA)	(50) National Aeronautics and Space Administration
(14) Operations and Maintenance, Army	(51) Department of Defense Dependent Schools
(18) Operations and Maintenance, Army Reserve	(53) Defense Communications Electronic Education Testing Act
Operations and Maintenance - Air Force (OMAF)	(54) Defense Logistics Agency
(24) Operations and Maintenance, Air Force	(55) Department of Energy
(29) Military Construction, Air Force (MX)	(56) Defense Mapping Agency
Other	(57) Defense Nuclear Agency
(16) Cemetery Funds	(58) Defense Communications Agency
(19) Other Army Funds	(59) Other Nondefense Federal Funds
(27) Nonappropriated Funds, Air Force	(60) Nonappropriated Funds, Army
(28) Other Air Force Funds	(61) Modernization of U.S. Facilities, Fed. Rep. of Germany
(30) Military Construction Navy	(62) Alternate Construction, Federal Republic of Germany
(31) Other Navy Funds	(64) Army/Air Force Exchange, Headquarters
(32) Navy and Marine Corps Reserves	(65) Army/Air Force Exchange, Local
(35) Nonappropriated Funds, Navy	(66) U.S. Soldier's and Airmen's Home
(36) Plant Replacement and Improvement	(69) National Security Agency
(41) Department of Defense Agencies	Production Base Support (PBS)
(46) Department of Defense Medical Facilities	(03)
(47) Voice of America	(04)
(48) Defense Language Institute	(15) Production Base Support

Note: Two-digit numbers refer to USACE fund type code.

TABLE F-7
USACE CUSTOMER CATEGORIES
(Military construction)

Defense Environment Restoration Program (DERP)	Foreign Military Sales (FMS) (Continued)
(05) Defense Environmental Restoration Act	(91) Engineer Assistance Program, Saudi Arabia
Family Housing – Army (FHA)	(92)
(40) Family Housing, New Construction	(93)
(42) Family Housing, Line Item Improvement	(95)
(44) Family Housing, Energy Conservation Investment Program	Host Nation (HN)
(45) Family Housing, Maintenance and Repair	(52) North Atlantic Treaty Organization
Family Housing – Air Force (FHAP)	(76) Government of Japan
(26) Family Housing, Air Force	(77) Government of Korea
Foreign Military Sales (FMS)	MILCON – Army (MCA)
(13) Military Assistance Program	(10) Military Construction, Army
(22) Military Assistance Program, Air Force	(11) Military Construction, Army, Unspecified Minor Const.
(63)	(17) Military Construction, Army National Guard
(67)	(98) Troop Support Agency, Headquarters
(68)	(99) Troop Support Agency, Local
(70) Foreign Military Sales	MILCON – Air Force (MCAF)
(74)	(20) Military Construction, Air Force
(78)	(21) Military Construction, Air Force Reserve
(80)	(23) Military Construction, Air Force, Minor Construction
(87)	(25) Military Construction, Air National Guard
(88)	(29) Military Construction, Air Force (MX)
(90)	

Note: Two-digit numbers refer to USACE fund type code.

(Continued)

TABLE F-7
USACE CUSTOMER CATEGORIES
(Military construction) (Continued)

MILCON – Army Reserve (MCAR)	Other (Continued)
(12) Military Construction, Army Reserve	(49) Operations and Maintenance DoD
Operations and Maintenance – Army (OMA)	(50) National Aeronautics and Space Administration
(14) Operations and Maintenance, Army	(51) Department of Defense Dependent Schools
(18) Operations and Maintenance, Army Reserve	(53) Defense Communications Electronic Education Testing Act
Operations and Maintenance – Air Force (OMAF)	(54) Defense Logistics Agency
(24) Operations and Maintenance, Air Force	(55) Department of Energy
(29) Military Construction, Air Force (MX)	(56) Defense Mapping Agency
Other	(57) Defense Nuclear Agency
(16) Cemetery Funds	(58) Defense Communications Agency
(19) Other Army Funds	(59) Other Nondefense Federal Funds
(27) Nonappropriated Funds, Air Force	(60) Nonappropriated Funds, Army
(28) Other Air Force Funds	(61) Modernization of U.S. Facilities, Fed. Rep. of Germany
(30) Military Construction Navy	(62) Alternate Construction, Federal Republic of Germany
(31) Other Navy Funds	(64) Army/Air Force Exchange, Headquarters
(32) Navy and Marine Corps Reserves	(65) Army/Air Force Exchange, Local
(35) Nonappropriated Funds, Navy	(66) U.S. Soldier's and Airmen's Home
(36) Plant Replacement and Improvement	(69) National Security Agency
(41) Department of Defense Agencies	Production Base Support (PBS)
(46) Department of Defense Medical Facilities	(03)
(47) Voice of America	(04)
(48) Defense Language Institute	(15) Production Base Support

Note: Two-digit numbers refer to USACE fund type code

TABLE F-8
USACE CUSTOMER CATEGORIES
(Civil works engineering)

Channels and harbors	Operation and maintenance – channels and harbors	
BB-210	BB-121	CA-110 N/A
Locks and dams	Operation and maintenance – locks and dams	
BB-220	B-122	CA-120 N/A
Beach erosion control	Operations and maintenance – flood control	
BD-400	BD-140	CB-200 N/A
Flood control	Operations and maintenance – flood control reservoirs	
BE-500	BE-150	CB-210 N/A
Flood control reservoirs	Operations and maintenance – multipurpose power	
BE-520	BE-152	CC-300 N/A
Multipurpose power	Operations and maintenance – channel and harbor improvements	
BF-600	BF-160	CB-220 N/A
Rehabilitation – channels and harbors	Flood control – emergency water supplies and drought assistance	
BH-813	N/A	DD-400 N/A
Rehabilitation – locks and dams	Flood control – rehabilitation	
BH-814	N/A	DC-300 N/A
EPA Superfund	EPA construction grants	
WU-940	WU-930	WH-960 N/A
		WH-970 N/A
		WH-980 N/A

TABLE F-9
USACE CUSTOMER CATEGORIES
(Civil works construction)

Channels and harbors BB-210 BB-21x	<i>Operation and maintenance – channels and harbors</i> CA-110 CA-11x
Locks and dams BB-220 BB-22x	<i>Operation and maintenance – locks and dams</i> CA-120 CA-12x
Beach erosion control BD-400 BD-4xx	<i>Operation and maintenance – flood control</i> CB-200 CB-2xx
Flood control BE-500 BE-5xx	<i>Operation and maintenance – flood control reservoirs</i> CB-210 CB-21x
Flood control reservoirs BE-520 BE-52x	<i>Operation and maintenance – multipurpose power</i> CC-300 CC-3xx
Multipurpose power BF-600 BF-6xx	<i>Operation and maintenance – channel and harbor improvements</i> CB-220 CB-22x
Rehabilitation – channels and harbors BH-813 N/A	<i>Flood control – emergency water supplies and drought assistance</i> DD-400 DD-4xx
Rehabilitation – locks and dams BH-814 N/A	<i>Flood control – rehabilitation</i> DC-300 DC-3xx
EPA Superfund WU-940 WU-94x	
EPA construction grants	
WH-960 WH-96x	
WH-970 WH-97x	
WH-980 WH-98x	